AVIATION WEATHER

HEARING

BEFORE THE

SUBCOMMITTEE ON
INVESTIGATIONS AND OVERSIGHT

AND THE

SUBCOMMITTEE ON TRANSPORTATION,
AVIATION AND MATERIALS

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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AVIATION WEATHER

WEDNESDAY, AUGUST 11, 1982

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS,

Washington, D.C.

The subcommittees met, pursuant to notice, at 9:30 a.m., in room 2325, Rayburn House Office Building, Hon. Albert Gore, Jr. (chairman of the Subcommittee on Investigations and Oversight) presiding.

Mr. GORE. The subcommittees will come to order.

I would like to welcome our witnesses and guests. The duty of a congressional oversight committee is not always a pleasant one. Reviewing the air safety program with a fatal air crash fresh in people's minds, this certainly falls into the unpleasant category. While it is not our effort here to fix the blame for a commercial air tragedy, it is, by the same token, a propitious time to review Federal responsibilities for safe air travel and insure that the public is getting the protection that it has a right to expect.

It has been an ongoing effort by these two subcommittees to insure that the scientific and technological basis for air safety is adequate. Last March we conducted hearings which examined such matters as deicing procedures, airline seats and technologies to measure runway friction, all of which focused on operating an airport in bad weather.

Today we will turn our attention to the more basic question of whether we can accurately detect what the weather is around an airport and what the most effective means is of transmitting that information to a pilot. Within the broad topic we would like to address specifically some of the following issues:

First, is weather given a sufficient institutional priority at the Federal Aviation Administration?

Second, what is the state of the art in our technology to detect such phenomenon as wind shear?

Third, are there corollaries to wind shear such as downbursts that might hinder takeoffs and landings.

Last, I would like to examine with the FAA a disturbing incident in Long Island where apparently a private plane was lost and procedures to institute a search for the plane were delayed for an unbelievable 2½ days. I would like to also call to the attention of our guests and witnesses the release of a report of these two subcommittees based on our previous inquiry which cites a number of

areas where the subcommittees believe the FAA could constructively improve its safety standards.

The cochairman of this hearing is Congressman Glickman of Kansas, chairman of the Transportation, Aviation and Materials Subcommittee.

Mr. GLICKMAN. Thank you, Mr. Chairman.

Today our subcommittees are going to address an issue that is critical to aviation safety, and that issue is aviation weather information. Weather continues to be a significant factor in aviation accidents. This year we have seen major air carrier accidents in which severe weather was clearly a key factor. In fact, from 1975 to 1980, weather was cited as a cause or significant factor in over half of all fatal U.S. air carrier accidents and 40 percent of fatal commuter and general aviation accidents.

Until recently, there were serious gaps in the process by which pilots receive weather reports. The Southern Airways accident, in 1977, in which 78 people were killed was a direct result of severe weather. Yet neither the pilots nor the air traffic controllers were aware of the intensity of the thunderstorm that caused the accident. We should never allow that kind of avoidable tragedy to occur again.

More recently, the Pan American accident at New Orleans was clearly weather related. Although it is unclear at this point what kind of weather information was available to the pilots, it is known that low level wind shear alerts were issued. If the purpose of our wind shear alert system is to prevent accidents, the system clearly failed.

I must say that the New Orleans accident raises some serious questions. What's the use of utilizing sophisticated technology for severe weather alerts if no one pays any attention to them, or if the information is not communicated to the pilots? If the aviation community has no confidence in current aviation weather technology, then we must move rapidly to improve that technology.

The Federal Aviation Administration's national airspace system plan calls for major enhancements in our aviation weather system through increased mechanization and improved technology. This committee is particularly interested in seeing that advanced technology is utilized to improve aviation safety through enhancing the quality and timeliness of weather information that is provided to pilots and, more importantly in many cases, air traffic controllers. Otherwise, we are poorly utilizing vital information that is available.

As we look at the needs and opportunities for improvement in the distribution of weather information to pilots, controllers, and other air traffic control personnel, 1 look forward to a very productive hearing and thank the expert witnesses who have agreed to assist us in this effort today.Thank you, Mr. Chairman.

Mr. GORE. Yes; thank you.

Without objection we will put into the record the opening statement of Bob Walker, the ranking minority member of the Oversight and Investigations Subcommittee and the statement of Jim Dunn, the ranking minority member of the Transportation, Aviation and Materials Subcommittee.

[The opening statements of Messrs. Walker and Dunn follow:]

Opening Remarks of Representative Robert S. Walker

Mr. Chairman, today we will hold the second day of hearings concerning air traffice safety, and I must say that I sincerely hope that we will be more encouraged today than we were last March.

The record of that hearing discloses a terrible tale of bureaucratic bungling. It shows that one of the agencies of our government which is charged with protection of the public has been so interested in dotting all of the I's and crossing all of the T's that they have probably endangered the public, and caused additional death and injury in otherwise survivable accidents.

Despite repeated reommendations from the National Transportation Safety Board, and recommendations going back for more than twenty years from their own medical experts that passenger seat standards be considerably strengthened to protect passengers, the FAA has consistently refused to issue new standards based on an untenable argument that they do not know exactly how much stress the human body can endure, and they don't want to issue standards which would exceed those maximum levels.

Our hearing today will examine a number of areas of air safety. They are each crucial to the safety of the flying public. Each day tens of thousands of Americans board airplanes to travel throughout the country. The average passenger believes that everything possible is being done to protect their safety. They expect that the carriers will operate the aircraft in a safe manner. They expect that the government will provide all possible weather information to ensure a safe flight.

They expect that the regulatory agencies will have promulgated the proper regulations and standards to protect them. And they expect that the aircraft and engine manufacturers have designed and built a safe product.

Unfortunately, our hearing in March indicated that most, if not all of these expectations are not being met.

There is no doubt that travel on a scheduled air carrier is still the safest form of travel. That is commendable. But it is not enough.

We hope that as a result of hearings such as this, and reports such as the one we will issue this morning, improvements can be made in the safety record of American air travel. We hope that many of the recommendations contained in our report will be adopted. We expect that many of our recommendations will closely parallel the recommendations that the NTSB will release today. Those expected similiarities are no accident. We discoverd last March that many of the concerns shared by Members of this Committee were also held by the Board. We urge the governmental agencies to examine these recommendations closely. They are our best estimate of specific things which must be done to make air travel safer. They are all things which are well within the capabilities of our current technology, and in the opinion of many Members of the Committee, there is no excuse for not undertaking them at once.

Opening Statement of Hon. Jim Dunn

Providing the pilot with accurate, timely weather information appears to be the key to significantly reducing accidents such as the recent tragedy in New Orleans, Over half of the airline accidents that occur today are weather related.

It is appropriate that we examine today the technology that exists or is being develped to aid the pilot in making the right decision, and assure ourselves that we are moving in the right direction.

I join with my colleagues in welcoming you gentleman here today, and I look forward to hearing your testimony.

Mr. Gore. Our first witness is Jim Burnett, Chairman of the National Transportation Safety Board.

You are accompanied, Mr. Burnett, by?

STATEMENT OF JAMES BURNETT, CHAIRMAN, NATIONAL TRANSPORTATION SAFETY BOARD, ACCOMPANIED BY WILLIAM LAYNOR, DEPUTY DIRECTOR FOR AVIATION TRANSPORTATION, BUREAU OF TECHNOLOGY; GREGORY D. SALOTTOLO, METEOROLOGIST, BUREAU OF TECHNOLOGY

Mr. BURNETT. Mr. William Laynor, Deputy Director for Aviation Transportation, Bureau of Technology, and Mr. Gregory D. Salottolo, meteorologist, from the Safety Board.

Mr. GORE. I would like to welcome all three of you. The two subcommittees are aware that you have a meeting that will be starting soon downtown.

Mr. BURNETT. Ten o'clock.

Mr. GORE. We are going to do our best to get you out of here as quickly as possible. Without objection the entire text of your prepared statement will be put into the record in full. If you care to summarize any portions of it, we invite you to do so.

Mr. BURNETT. Mr. Chairman, my statement is a summary of a complex issue. I think to summarize it more would really be to derogate it. I am going to probably read most of it.

Mr. Chairman and members of the committee, I am pleased to be here this morning to present testimony on behalf of the National Transportation Safety Board on reducing weather-related aviation accidents.

As you know, until January of this year, our country had enjoyed a period unsurpassed in air carrier aviation safety—26 months without a major fatal accident. Unfortunately, this record was ended on January 13, 1982 when an Air Florida B-737 struck the 14th Street Bridge and crashed into the Potomac River here in Washington killing 74 people in the airplane and 4 people on the bridge. This was followed only 10 days later by the World Airways DC-10 runway overrun accident at Logan Airport in Boston in which two people perished. Both of those accidents occurred in winter storm conditions. On July 9, 1982, there was still another catastrophic accident when Pan American World Airways Flight 759, a Boeing 727, crashed into a residential area just after takeoff from New Orleans, Thunderstorms were present in the area at the time of the accident. All 146 people on the aircraft and 8 people on the ground were killed.

The Safety Board considered the report for the Air Florida accident just yesterday and the investigation of the World Airways accident in Boston is nearly complete. We meet this morning at 10 a.m. Of course, we are still intensely involved in the investigation of the Pan American accident. However, even at this point I think it safe to say that the prevailing weather was a major factor in all three of these accidents.

Since the beginning of aviation, weather has been and remains an extremely significant factor in the causation of accidents. The percentage of accidents which involve weather has remained essentially constant through the years, even though the technology used for weather detection has become much more sophisticated. Certainly the ability to forecast more accurately and the ability to monitor real-time conditions has been enhanced during the years.

Nonetheless, approximately 40 percent of all fatal general aviation accidents involve weather and over 50 percent of all air carrier accidents are, in some way, attributable to the weather. Of course, the concurrent technological advances in aircraft and aircraft instrumentation have enhanced the aircraft's and the pilot's ability to operate during generally adverse weather conditions which at one time would have stopped airborne operations. Thus, while gaining in the ability to forecast and monitor weather, the potential exposure of aircraft to adverse weather conditions has increased.

Weather-involved accidents occur during all phases of flight, takeoff, en route, terminal approach, and landing. The three air carrier accidents which have occurred this year involved the most significant types of accident-producing weather phenomena. These phenomena include winter conditions conducive to both airframe icing which can significantly affect the airplane's flying qualities and the accumulation of snow or ice on runways which can affect the aircraft's ability to stop within the runway length; and second, the thunderstorms which can produce local high wind velocities with rapidly shifting direction, heavy rain or hail, and sometimes gusts which exceed the airplane's structural limits. Clear air turbulence is another frequent cause of accidents, albeit their consequences have been generally limited to moderately serious flightcrew or passenger injuries.

The Safety Board believes that the accident record indicates that weather-involved accidents will continue so long as aircraft are exposed to the more serious of these hazards. Therefore, we believe that the only viable solution is to prevent such exposure. The means to do this are through accurate forecasting of the weather, assurance that the most recent forecast reaches the pilot before he departs, providing the pilot with continual update of the weather as he prepares for takeoff, transits his route of flight, and approaches his terminal area. Most of all, the pilot must be given sufficient information upon which he can base his key decisions, that is, should he delay his departure? Deviate from his planned route? Or proceed to his alternate destination?

The Safety Board has examined a wide range of these problems during its accident investigations, and I will discuss some of our findings, our concerns, and our recommendations. First, the problems with winter operations. In the Air Florida crash into the 14th Street Bridge, the Board did not find that forecasting or the transmittal of prevailing weather conditions was an issue. Certainly, the pilot was well aware of the weather and the airport conditions as the flight was delayed about 50 minutes awaiting takeoff. The bigger question in this accident was whether the flightcrew were adequately knowledgeable about their aircraft's performance and proper winter operating procedures. That issue, however, is beyond the scope of this testimony.

The World Airways DC–10 accident in Boston is a better example of the problem of dissemination of information to a flightcrew. In this case, it is not so much the transmittal of current weather information as it was the transmittal of the airport runway conditions. Although the Board has not yet considered all of the evidence for causal analysis, we do know that the airplane, a heavy

DC-10, landed on an icy, extremely slippery runway and failed to stop, ending up in water beyond the far end of the runway. Several issues are involved.

The Safety Board held a 3-day hearing in May of this year to examine many of the issues raised by the Boston accident, as well as other accidents. We found there has been no standardized acceptance of a reliable means of measuring runway braking friction, nor of criteria on when to close a runway. Today we continue to rely primarily on the reports which pilots who have landed provide to the local controller or ground control. Our experience indicates that these reports may not always be given to a pilot making a landing, and that because of the subjectivity associated with the pilot's assessment, they are of limited use to a pilot in deciding whether he can land and stop safely. A report from a pilot of a light twin engine transport might be very misleading to a pilot of a heavy wide-bodied aircraft.

The second weather hazard, and certainly the one which is or should be most respected by pilots is the severe thunderstorm. Since 1962, there have been 127 U.S. air carrier accidents in which thunderstorm activity was found to be either a cause or a factor. These accidents cost 545 lives and 260 injuries.

While accurate forecasting by the Weather Service and the availability of the latest weather information may help a pilot to avoid severe weather, that alone is not enough. The rapid development and fast movement of convective activity of severe thunderstorms and transient wind shear conditions make it absolutely essential that pilots who elect to fly in the vicinity of areas of unfavorable weather are kept aware of the actual weather along their route of flight.

The ability to accomplish the latter safely necessitates, first, the ability of the system to detect the real-time weather conditions, and second, the ability of the system to communicate the real-time weather conditions. By that, I mean the "right now" existing weather, the actual location and severity of thunderstorms which must be communicated to air traffic controllers so that they can plan the movements and possible changes in routing of flights under their control, and to the pilots of those flights who must make critical decisions based on that knowledge.

Although airborne weather radar and thunderstorm detection devices are intended to augment the ground-based weather detection and dissemination system, our accident data indicate that these have some inherent shortcomings and limitations and that they alone cannot assure safe passage through a severe weather area. The Board is aware of the continuing research efforts to develop airborne systems based on laser technology to provide forward looking turbulence detection capability. The Board believes that R&D programs and regulatory requirements to implement these systems along with new technology doppler radar should be given major emphasis by FAA.

The Safety Board has made many recommendations for improvements in all of these areas. However, never was the need for improvement so forcefully brought home as it was following the tragic crash of a DC-9 in New Hope, Ga. on April 4, 1977. That aircraft was approaching Atlanta when it entered a thunderstorm be-

tween 17,000 feet and 14,000 feet. The ingestion of massive amounts of water and hail induced severe engine stalls and caused major engine damage resulting in total thrust loss. Ironically, people on the ground in their kitchens or in their automobiles listening to local broadcasting stations had more current knowledge of the weather and its severity than the flightcrew of the DC-9.

The Safety Board cited the Federal Aviation Administration's air traffic control system which did not provide for the timely dissemination of real-time hazardous weather information to the flightcrew as a major contributing factor in the accident. The Board issued six safety recommendations to the FAA in September 1977, which the Board felt would rectify the problem. The most significant of these recommendations called for development of an aviation weather subsystem capable of providing a real-time display and classification of precipitation or turbulence for immediate transmission to pilots, and more frequent transmission of convective sigmet (significant meteorological) messages.

While we recognized that our recommendations would require some long-term actions, we were dismayed and profoundly concerned when, on June 12, 1980, a Swearinger SA226 turboprop aircraft operating as an air carrier crashed near Valley, Nebr., taking 13 lives. The circumstances of the accident were strikingly similar to those of the DC-9 accident 3 years earlier in Georgia. The aircraft encountered severe thunderstorms and experienced a loss of power in both engines because of massive water ingestion.

Again, the Board cited the failure of the air traffic control system to disseminate critical weather information to the air traffic control and in turn to the crew of the aircraft, and the failure of Center Weather Service Unit meteorologists to disseminate weather information on the approach control supervisors as contributing factors. The inherent limitations of x-band radars was also cited as a contributing factor.

Once again, the Board reiterated those previous recommendations expressing our concern regarding the need for real-time weather data for ATC users and urged FAA to expedite current programs. The Board also issued 10 additional recommendations to the FAA and 2 to the National Weather Service. Most were directed toward improvements in the use of presently available weather equipment and procedures to insure positive dissemination of hazardous weather information to air traffic control and pilots, actions which we believe could be taken quickly. I will be happy to provide those recommendations for the record.

[Referenced material follows:]

Fifteen days after the accident the Safety Board issued ten recommendations concerning winter-weather operations to the FAA. Today the Board approved the following additional recommendations.

Issue a Maintenance Alert Bulletin to require Principal Maintenance Inspectors to emphasize to air carrier maintenance departments that proper maintenance of ground support equipment may be critical to flight operations and the importance of adhering to maintenance practices recommended by the manufacturers of such equipment.

Issue a Maintenance Alert Bulletin to require Principal Maintenance Inspectors to review contract agreements between an air carrier operating into a facility at which another air carrier or maintenance contractor is providing maintenance services to assure that the responsibilities of both parties and key personnel are clearly

defined and that the contractor providing the maintenance is thoroughly familiar with the maintenance of the type of aircraft involved.

Issue an Operations Alert Bulletin to require Principal Operations Inspectors to require that air carrier training programs adequately cover the effects of aircraft leading edge contamination on aerodynamic performance, particularly as it affects the relationship between airspeed and angle of attack and those functions whose activation is dependent on the angle of attack, such as stall warning systems and autothrottle speed command systems.

Require revision of the B-737 Approved Flight Manual to add "anti-ice" to the normal taxi and takeoff checklist. Review the checklists for all air carrier aircraft to ensure that all action items required for a successful takeoff are included on the appropriate checklist. Special consideration should be given to items whose functions may be affected by environmental conditions subject to change during ground delay periods.

Issue an Airworthiness Directive to implement the necessary airplane modifications and/or changes in operational procedures for B-737 aircraft takeoff operations during weather or runway conditions conducive to the information of leading edge frost, snow, or ice contamination to require either: (1) that the leading edge is free of frozen contaminant through the pretakeoff use of a ground-operable wing thermal anti-ice system, or (2) an increased stall airspeed margin at liftoff which will provide adequate pitch and roll control to counter the effects of undetected leading edge contaminants by modification of takeoff flaps configuration and/or increased takeoff airspeed schedules.

Amend Air Traffic Control coordination procedures and practices to require that terminal and en route facilities provide the Central Flow Control Facility (CFCF) with current and accurate information regarding congestion and that CFCF act on that information in a positive manner to minimize airport saturation and extensive traffic delays. Review implementation of prescribed gate-hold procedures and require their use wherever possible.

Issue a General Notice to terminal area Air Traffic Control facilities to emphasize to controllers that the separation criteria set forth in FAA Air Traffic Control Handbook 7110.65C which require a minimum of 2 miles separation do not permit deviation based upon the anticipated acceleration differences between landing and departing traffic.

Evaluate the criteria and current practices of Air Traffic Control facilities regarding the declaration and reporting of operational errors to ensure that all such errors are reported and are investigated.

Provide for essential equipment and increased personnel training to improve the water rescue capabilities at the Washington National Airport in all anticipated weather conditions, and provide necessary funding for surrounding communities and jurisdictions which will be called on to support the airport's rescue response.

Survey all certificated airports having approach and departure flightpaths over water and evaluate the adequacy of their water rescue plans, facilities, and equipment according to the guidance contained in Advisory Circular 150/5210-13 and make recommendations for improvement as necessary to appropriate airport authorities.

Amend 14 CFR 139.55 to require adequate water rescue capabilities at airports having approach and departure flightpaths over water which are compatible with the range of weather conditions which can be expected.

The Safety Board's complete printed report will be available in approximately one month. Copies of this report, which should be identified as PB-82-910408 may be purchased by mail from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

Mr. BURNETT. We are pleased to see that some actions have been taken to improve this situation. While a reliable and useful display of weather on the air traffic controllers scope has yet to become a reality, such systems are under development. In the meantime, center weather service units have been placed in air route traffic control centers. These units are comprised of a staff of National Weather Service metecrologists who have communications systems to keep abreast of the weather in the ARTCC's area of responsibility. They advise controllers within the center and associated terminal facilities of changing weather conditions, particularly severe convective activity.

These center weather service units are scheduled to be equipped with color weather radar remote displays which will provide the best real-time presentation of convective activity to the meteorologists. Federal Aviation Administration informed the Board that all centers would be so equipped by May 1982, but we now understand that the delivery dates have slipped. The Board still encourages the FAA to expedite this program. Furthermore, we believe that air traffic control must place more emphasis on using the information provided by the CWSU's in effective traffic control. We still look forward, however, to more effective measures such as the integration of weather radar/air traffic control radar displays which will be attained with the next generation radar.

Finally, I must discuss our longstanding and continuing concern regarding wind shear in the terminal area, and the emphasis we believe must be placed in dealing with its effects. Although the effects of wind shear have been a recognized problem since the beginning of aviation, it was the tragic crash of the Eastern Air Lines B-727 inbound to JFK Airport on June 24, 1975 and which cost 113 lives that allowed us to focus on the cause and profoundly exemplified the need for timely and positive action. That accident occurred as the aircraft penetrated a thunderstorm on final approach. The aircraft experienced a rapid loss of airspeed as it encountered the outflowing winds and the downdraft associated with the storm.

The Safety Board issued 14 safety recommendations following that investigation. The most significant of these were directed toward the development and installation of equipment which would monitor winds on the approach and departure paths of air carrier airports, the determination of operational limitations for various types of aircraft which could be correlated to measured conditions, the development of airborne wind shear detection and vertical guidance equipment, and emphasis on pilot understanding of the wind shear environment.

Shortly after this accident, the FAA undertook an extensive R&D program addressing most of the issues in the Safety Board's recommendations. The program was given added emphasis as a result of three more air carrier accidents associated with wind shear penetration between 1975 and 1977. Several positive actions did come out of the effort. Pilot training programs were enhanced, operational techniques were evaluated in simulation, both ground-based and airborne wind shear detection and monitoring equipment were evaluated.

It is, therefore, extremely frustrating to the Safety Board that the only tangible action implemented was the FAA's installation of the low level wind shear alert system, an anemometer array around airports to provide local controllers and thus pilots with indications of shifting ground level winds. This action was initially touted as an interim measure to ultimately be augmented with more sophisticated equipment and corresponding operational procedures. The early phases of the investigation of the Pan American accident convince the Board that the local level wind shear alert system is not the end solution.

Furthermore, since neither the FAA nor the air carriers have implemented operational procedures to use the LLWSAS as a criteria for approach or departure, its ultimate value in accident pre-

vention is not realized. We believe most of the concerns which our recommendations of 1976 addressed remain valid. The FAA published a proposed advisory circular on July 26 establishing standards for approval of airborne wind shear detection systems. The Board believes that such systems should become a requirement for air carrier aircraft.

However, these too, while they may be effective for en route and approach phases of flight, will be of limited value to a heavy airplane, already at takeoff power, which encounters severe wind shear at low altitude after takeoff. The Board continues to believe that accurate ground-based measuring equipment and correlatable operational limitations established for the aircraft are needed so that pilots and controllers can make safe go/no-go decisions.

Thank you, Mr. Chairman. I will be happy to answer any questions you or the members of the committee may have.

The Board is waiting for me to begin a meeting at 10 o'clock. I would like to leave as soon as possible.

[The prepared statement of Mr. Burnett follows:]

STATEMENT OF

JIM BURNETT, CHAIRMAN

NATIONAL TRANSPORTATION SAFETY BOARD

Mr. Chairman and Members of the Committee. I am pleased to be here this morning to present testimony on behalf of the National Transportation Safety Board on reducing weather-related aviation accidents.

Before I begin, I would like to introduce the staff members with me today. To my left is Mr. William Laynor, Deputy Director for Aviation Transportation, Bureau of Technology, and to my right is Mr. Gregory D. Salottolo, Meteorologist, Bureau of Technology.

As you know, until January of this year, our Country had enjoyed a period unsurpassed in air carrier aviation safety -- 26 months without a major fatal accident. Unfortunately, this record was ended on January 13, 1982 when an Air Florida B-737 struck the 14th Street Bridge and crashed into the Potomac River here in Washington killing 74 people in the airplane and 4 people on the Bridge. This was followed only 10 days later by the World Airways DC-10 runway overrun accident at Logan Airport in Boston in which two people perished. Both of those accidents occurred in winter storm conditions. On July 9, 1982, there was still another catastrophic accident when Pan American World Airways Flight 759, a Boeing 727, crashed into a residential area just after takeoff from New Orleans, Louisiana. Thunderstorms were present in the area at the time of the accident. All 146 people on the aircraft and eight people on the ground were killed.

The Safety Board considered the report for the Air Florida accident just yesterday and the investigation of the World Airways accident in Boston is nearly complete. Of course, we are still intensely involved in the investigation of the Pan American accident. However, even at this point I think it safe to say that the prevailing weather was a major factor in all three of these accidents.

Since the beginning of aviation, weather has been and remains an extremely significant factor in the causation of accidents. The percentage of accidents which involve weather has remained essentially constant through the years, even though the technology used for weather detection has become much more sophisticated. Certainly the ability to forecast more accurately and the ability to monitor real-time conditions has been enhanced during the years. Nonetheless, approximately 40 percent of all fatal general aviation accidents involve weather and over 50 percent of all air carrier accidents are, in some way, attributable to the weather. Of course, the concurrent technological advances in aircraft and aircraft instrumentation have enhanced the aircraft's and the pilot's ability to operate during generally adverse weather conditions which at one time would have stopped airborne operations. Thus, while gaining in the ability to forecast and monitor weather, the potential exposure of aircraft to adverse weather conditions has increased.

Weather-involved accidents occur during all phases of flight, takeoff, enroute, terminal approach and landing. The three air carrier accidents which have occurred this year involved the most significant types of accident-producing weather phenomena. These phenomena include winter conditions conducive to both airframe icing which can significantly effect the airplane's flying qualities and the accumulation of snow or ice on runways which can effect the aircraft's ability to stop within the runway length; and second, the thunderstorms which can produce local high wind velocities with rapidly shifting direction, heavy rain or hail, and sometimes gusts which exceed the airplane's structural limits. Clear air turbulence is another frequent cause of accidents, albeit their consequences have been generally limited to moderately serious flightcrew or passenger injuries.

The Safety Board believes that the accident record indicates that weather-involved accidents will continue so long as aircraft are exposed to the more serious of these hazards. Therefore, we believe that the only viable solution is to prevent such exposure. The means to do this are through accurate forecasting of the weather, assurance that the most recent forecast reaches the pilot before he departs, providing the pilot wich continual update of the weather as he prepares for takeoff, transits his route of flight, and approaches his terminal area. Most of all, the pilot must be given sufficient information upon which he can base his key decisions, that is, should he delay his departure? Deviate from his planned route? Or proceed to his alternate destination?

The Safety Board has examined a wide range of these problem areas in its accident investigations, and I will discuss some of our findings, our concerns, and our recommendations. First, the problems with winter operations. In the Air Florida crash into the 14th Street Bridge, the Board did not find that forecasting or the transmittal of prevailing weather conditions was an issue. Certainly, the pilot was well aware of the weather and the airport conditions as the flight was delayed about 50 minutes awaiting takeoff. The bigger question in this accident was whether the flightcrew were adequately knowledgeable about their aircraft's performance and proper winter operating procedures. That issue, however, is beyond the scope of this testimony.

The World Airways DC-10 accident in Boston is a better example of the problem of dissemination of information to a flightcrew. In this case, it

is not so much the transmittal of current weather information as it was the transmittal of the airport runway conditions. Although the Board has not yet considered all of the evidence for causal analysis, we do know that the airplane, a heavy DC-10, landed on an icy, extremely slippery runway and failed to stop, ending up in water beyond the far end of the runway. Several issues are involved.

The Safety Board held a three-day hearing in May of this year to examine many of the issues raised by the Boston accident, as well as other accidents. We found there has been no standardized acceptance of a reliable means of measuring runway braking friction, nor of criteria on when to close a runway. Today we continue to rely primarily on the reports which pilots who have landed provide to the local controller or ground control. Our experience indicates that these reports may not always be given to a pilot making a landing, and that because of the subjectivity associated with the pilot's assessment, they are of limited use to a pilot in deciding whether he can land and stop safely. A report from a pilot of a light twin engine transport might be very misleading to a pilot of a heavy wide-bodied aircraft.

The second weather hazard, and certainly the one which is or should be most respected by pilots is the severe thunderstorm. Since 1962, there have been 127 U.S. air carrier accidents in which thunderstorm activity was found to be either a cause or a factor. These accidents cost 545 lives and 260 injuries.

While accurate forecasting by the Weather Service and the availability of the latest weather information may help a pilot to avoid severe weather, that alone is not enough. The rapid development and fast movement of convective activity of severe thunderstorms and transient windshear conditions make it absolutely essential that pilots who elect to fly in the vicinity of areas of unfavorable weather are kept aware of the actual weather along their route of flight.

The ability to accomplish the latter safely necessitates, first, the ability of the system to detect the real-time weather conditions, and second, the ability of the system to communicate the real-time weather conditions. By that, I mean the "right now" existing weather, the actual location and severity of thunderstorms which must be communicated to air traffic controllers so that they can plan the movements and possible changes in routing of flights under their control, and to the pilots of those flights who must make critical decisions based on that knowledge. Although airborne weather radar and thunderstorm detection devices are intended to augment the ground-based weather detection and dissemination system, our accident data indicate that these have some inherent shortcomings and limitations and that they alone cannot assure safe passage through a severe weather area. The Board is aware of the continuing research efforts to develop airborne systems based on laser technology to provide forward looking turbulence detection capability. The Board believes that R&D programs and regulatory requirements to implement these systems along with new technology doppler radar should be given major emphasis by FAA.

The Safety Board has made many recommendations for improvements in all of these areas. However, never was the need for improvement so forcefully brought home as it was following the tragic crash of a DC-9 in New Hope, Georgia on April 4, 1977. That aircraft was approaching Atlanta when it entered a thunderstorm between 17,000 feet and 14,000 feet. The ingestion of massive amounts of water and hail induced severe engine stalls and caused major engine damage resulting in total thrust loss. Ironically, people on the ground in their kitchens or in their automobiles listening to local broadcasting stations had more current knowledge of the weather and its severity than the flightcrew of the DC-9. The Safety Board cited the Federal Aviation Administration's air traffic control system which did not provide for the timely dissemination of real-time hazardous weather information to the flightcrew as a major contributing factor in the accident. The Board issued six safety recommendations to the FAA in September, 1977, which the Board felt would rectify the problem. The most significant of these recommendations called for development of an aviation weather subsystem capable of providing a real-time display and classification of precipitation or turbulence for immediate transmission to pilots, and more frequent transmission of convective sigmet (significant meteorological) messages.

While we recognized that our recommendations would require some long-term actions, we were dismayed and profoundly concerned when, on June 12, 1980, a Swearinger SA226 turboprop aircraft operating as an air carrier crashed near Valley, Nebraska, taking 13 lives. The circumstnaces of the accident were strikingly similar to those of the DC-9 accident three years earlier in Georgia. The aircraft encountered severe thunderstorms and experienced a

loss of power in both engines because of massive water ingestion. Again, the Board cited the failure of the air traffic control system to disseminate critical weather information to the air traffic controllers and in turn to the crew of the aircraft, and the failure of Center Weather Service Unit meteorologists to disseminate weather information to the approach control supervisors as contributing factors. The inherent limitations of x-band radars was also cited as a contributing factor.

Once again, the Board reiterated those previous recommendations expressing our concern regarding the need for real time weather data for ATC users and urged FAA to expedite current programs. The Board also issued ten additional recommendations to the FAA and two to the National Weather Service. Most were directed toward improvements in the use of presently available weather equipment and procedures to ensure positive dissemination of hazardous weather information to air traffic control and pilots, actions which we believe could be taken quickly. I will be happy to provide those recommendations for the record.

We are pleased to see that some actions have been taken to improve this situation. While a reliable and useful display of weather on the air traffic controllers scope has yet to become a reality, such systems are under development. In the meantime, Center Weather Service Units have been placed in air route traffic control centers. These units are comprised of a staff of National Weather Service meteorologists who have communications systems to keep abreast of the weather in the ARTCC's area of responsibility. They advise controllers within the Center and associated terminal facilities

of changing weather conditions, particularly severe convective activity. These Center Weather Service units are scheduled to be equipped with color weather radar remote displays which will provide the best "real time" presentation of convective activity to the meteorologists. Faa informed the Board that all centers would be so equipped by May 1982, but we now understand that the delivery dates have slipped. The Board still encourages the FAA to expedite this program. Furthermore, we believe that ATC must place more emphasis on using the information provided by the CWSU's in effective traffic control. We still look forward, however, to more effective measures such as the integration of weather radar/air traffic control radar displays which will be attained with the next generation radar.

Finally, I must discuss our long-standing and continuing concern regarding windshear in the terminal area, and the emphasis we believe must be placed in dealing with its effects. Although the effects of windshear have been a recognized problem since the beginning of aviation, it was the tragic crash of the Eastern Air Lines B-727 inbound to JFK Airport on June 24, 1975 and which cost 113 lives that allowed us to focus on the cause and profoundly exemplified the need for timely and positive action. That accident occurred as the aircraft penetrated a thunderstorm on final approach. The aircraft experienced a rapid loss of airspeed as it encountered the outflowing winds and the downdraft associated with the storm. The Safety Board issued 14 safety recommendations following that investigation. The most significant of these were directed toward the development and installation of equipment which would monitor winds on the approach and departure paths of air carrier airports, the determination of operational limitations for various types of aircraft which could be correlated to measured conditions, the development of airborne windshear detection and vertical guidance equipment, and emphasis on pilot understanding of the windshear environment.

Shortly after this accident, the FAA undertook an extensive R&D program addressing most of the issues in the Safety Board's recommendations. The program was given added emphasis as a result of three more air carrier accidents associated with windshear penetration between 1975 and 1977. Several positive actions did come out of the effort. Pilot training programs were enhanced, operational techniques were evaluated in simulation, both ground based and airborne wind shear detection and monitoring equipment were evaluated.

It is, therefore, extremely frustrating to the Safety Board that the only tangible action implemented was the FAA's installation of the low level wind shear alert system, an anemometer array around airports to provide local controllers and thus pilots with indications of shifting ground level winds. This action was initially touted as an interim measure to ultimately be augmented with more sophisticated equipment and corresponding operational procedures. The early phases of the investigation of the Pan American accident convince the Board that the LLWSAS is not the end solution. Furthermore, since neither the FAA nor the air carriers have implemented operational procedures to use the LLWSAS as a criteria for approach or departure its ultimate value in accident prevention is not realized. We believe most of the concerns which our recommendations of 1976 addressed remain valid. The FAA published a proposed advisory circular on July 26 establishing standards for approval of airborne windshear detection systems. The Board believes that such systems should become a

requirement for air carrier aircraft. However, these too, while they may be effective for enroute and approach phases of flight, will be of limited value to a heavy airplane, already at takeoff power, which encounters severe wind shear at low altitude after takeoff. The Board continues to believe that accurate ground based measuring equipment and correlatable operational limitations established for the aircraft are needed so that pilots and controllers can make safe go/no go decisions.

Thank you, Mr. Chairman. This concludes my prepared remarks. I will be happy to answer any questions you or the Members of the Committee may have.

Mr. GORE. Thank you, Mr. Burnett. I think that was excellent testimony. You have had a tough watch since you took over at NTSB.

Mr. BURNETT. Unfortunately, that is true.

Mr. GORE. You have impressed a lot of people who have been watching your performance. These subcommittees certainly appreciate the job that you have been doing. I would say to my colleagues that we ought to hold the questions short so that Mr. Burnett can get back.

Chairman Glickman.

Mr. GLICKMAN. Just a quick question. I want to also indicate that your testimony is excellent. But in my judgment it is a frightening piece of testimony because the essence of what you have said was that the Board has issued many safety recommendations over the last several years regarding weather, wind shear, weather information availability, and access to information, and that the FAA has not responded, either with any form of regulatory change, nor have they moved fast enough with some of their facilities and equipments. Am I paraphrasing you correctly?

Mr. BURNETT. I think the facts are frightening. I don't intend to frighten people with the testimony except as the facts so speak. The history of this issue and the treatment of this issue by the Federal Aviation Administration indicates that there is a problem with follow through. I think many of the projects that we recommended were begun with good faith. I am sure that the people in the Federal Aviation Administration are as anxious to save lives as the people at the Safety Board. But there has been, for either institutional or bureaucratic reasons, a failure to follow through.

We saw this, I think very dramatically, when we had our hearings in March on the Air Florida accident. There was testimony from an FAA witness about an FAA research project that they had begun in response to some of our recommendations that dealt with proper means for deicing and anti-icing aircraft. That testimony revealed that this research project was more on paper than it was in

fact. It would be, I think, interesting for the members and their staff to read that testimony. And I think we can provide it.

I think it shows——

Mr. GLICKMAN. We have it.

Mr. GORE. Have you seen it? It was very alarming to me to know that we had apparently funds being devoted to that. The Safety Board had been told that the FAA had a program. And when we had another accident and a chance to examine their program, we found out that in reality, they had not been responsive.

Mr. GLICKMAN. Partly in response to their report and our own hearings we have included recommendations in the subcommittee report that really calls on FAA to move ahead with the regulatory action based on the deicing information.

Thank you, Mr. Chairman.

Mr. GORE. Mr. Dymally.

Mr. DYMALLY. Thank you, Mr. Chairman.

Do you have any statutory authority to enforce your recommendations when submitted to the FAA?

Mr. BURNETT. No, we have none, and we seek none. Once we acquired that kind of authority we would be part of the problem and would need to be investigated in a sense. But our influence is the power of public opinion which can be directed toward the problem when we investigate an accident.

As you know, most of the safety reforms, unfortunately, that take place in the country take place in response to accidents. We try to marshal the facts and focus public attention so that we can get meaningful reforms. Often we are very effective but not as effective as we would like to be.

Mr. DYMALLY. Therefore, you find these hearings very helpful in terms of arousing public opinion and putting pressure on the FAA to comply——

Mr. BURNETT. I certainly do. I think they are helpful and necessary.

Mr. DYMALLY. Thank you, Mr. Chairman.

Mr. GORE. Mr. Shamansky.

Mr. SHAMANSKY. Thank you, Mr. Chairman.

I wrote down a question here for you. It says does the National Transportation Safety Board talk to the Federal Aviation Administration except immediately after an accident?

Mr. BURNETT. Oh, yes. We have ongoing relationships with them. We do have a problem, though. I think this, this is maybe to what you are going to. We have never been staffed or budgeted or organized to have an ongoing audit——

Mr. SHAMANSKY. That is what I am after. Why not?

Mr. BURNETT [continuing]. Of their compliance with our safety recommendations.

Mr. SHAMANSKY. Why not?

Mr. BURNETT. We just never have had the capacity to do that.

Mr. SHAMANSKY. That is like saying "well, that is the way we have always done it" kind of a thing.

Mr. BURNETT. I am not saying it is right. That is a problem we need to address, but it is partly in resources. We have a 290-person staff spread out in 10 field offices to handle 5 modes of transportation all over the country.

Mr. SHAMANSKY. When you say it is a problem you need to address, you just now concluded that it is a problem you needed to address?

Mr. BURNETT. No, I have thought ever since I arrived that——

Mr. SHAMANSKY. How much noise have you made about that?

Mr. BURNETT. Let me say that we are trying to do what we can with the resources we have to get recommendations followed up and improve the job we are doing. But I consider that one of the major failures of our effort. We are going to address it as best we can, and to the extent that we can have additional resources to do that——

Mr. SHAMANSKY. Judge, I am also a lawyer. Every time we put a qualifier—as best we can, and so on—those are marvelous loopholes we all drive through. I am not condemning you. I just want to get it out on the table that you have carefully qualified each of these statements.

I am trying to say to you that you have, I think, a direct responsibility not to worry about the loopholes and go after Mr. Stockman, whoever else it is that isn't giving you enough money or staff to do these things, because it is apparent that, you know, they gain attention every time we have an accident.

I am pleased—don't misunderstand me. I am very pleased with your recommendations. I think, I really do like your candor. The point is, though, it doesn't correct the problem. I think you have got to identify the problem and stick with it. You may be a fly in the ointment, but I think that is your job. That is what you are here for.

Mr. BURNETT. I agree.

Mr. SHAMANSKY. I regret that, you know, you haven't been able to do—get through those loopholes before. But I want to encourage you to do just exactly what you are doing. But you have got to make more noise.

Mr. BURNETT. That is what we are doing today, I believe.

Mr. SHAMANSKY. Good. We want to help you do that.

Mr. GORE. Some weeks ago Chairman Glickman and I coauthored a letter to the President concerning the NTSB's budget. You said at our earlier hearings that if there was another major crash you would not be able to finish out the year. You would have to delay any further investigations.

Mr. BURNETT. I think I was misunderstood, Mr. Chairman. What I intended to say, was that if we had had another major incident at that time, while we had several "go" teams already out in the field, I didn't know how we would handle it because we simply would not have the people to do it.

In many of our areas of technical expertise, we only have two people per specialty. If we have two accidents and we had two at that time, because we had Air Florida and the World accident in Boston, if we had had another on top of that, we just simply would not have had the people to do it.

Mr. GORE. You also said you wouldn't have the money to do it. Is that still the case?

Mr. BURNETT. We have problems, and we have sent out a notice of furlough to our staff. We are hopeful we will not have to implement that. Every accident has a cost associated with wreckage re-

moval and travel and those things that are very hard to predict because they differ very much from accident to accident. Obviously, our financial problems have been made more difficult because of that. We are investigating that. And we are going to be able to hold a public hearing, which we had to look very carefully to see if we were going to have the money to do. That may represent another day of furlough for our people.

Mr. GORE. In fact, you had to delay the hearings, did you not, because of that?

Mr. BURNETT. We were afraid that we might have to until after the fiscal year. However, in assessing that whole situation we thought that even if it meant additional furlough time, it was better for us to go ahead and address those issues in a timely fashion. We did have deliberation within our administrative structure about whether to do that.

Mr. GORE. So in effect you have been given a choice of either delaying investigations and hearings that relate to the public's safety on air travel on the one hand, or laying off or furloughing your employees on the other.

Mr. BURNETT. Yes. I would emphasize that I still have hopes we will not have to furlough. That depends very much on our accident record from now until the end of the fiscal year.

Mr. GORE. As I said before, you have had a tough watch. It just seems to me that we ought to recognize that tragedies, unforeseen, dictate the scope of your mission, not economic theory, and we ought to make adjustments accordingly.

Now let me ask you briefly, why is it in your opinion that the FAA is so slow to put into effect recommendations that you believe so strongly could save lives?

Mr. BURNETT. Well, on many of the recommendations we make, they are very prompt about it. Those are the highly technical ones which involve the issuance of airworthiness directives and that sort of thing. The problem we have is with the long-range recommendations, some of which involve major questions of public policy, and it is sort of like trying to turn a ship around. And I think the problem that I am most concerned with here is not their quickness to implement them, but their lack of followthrough. They often initiate but we don't have ongoing implementation.

There is another——

Mr. GORE. But it is not just a question of policy. There are specific recommendations. The National Transportation Safety Board investigates a crash, they find out causes that could be avoided in the future. They make recommendations to the FAA and the FAA drags its feet. How do we stop that?

Mr. BURNETT. In fairness I think we would say the FAA have acted favorably on 80 percent of our recommendations. I am trying to be fair to them. At least they tell us they do. Sometimes of course we find out that they have said they are implementing them, and not in fact. Sometimes it takes another accident to shed light on that. I think another area that I hope the committee will address is the fact that because there is slowness to implement some of the recommendations, the technology outstrips the recommendation before it is implemented.

Then there is a tendency to say no, we don't want to do this because we have this much better system over here. That tends to happen again and again and again, so that you are back using very primitive technology that has been outstripped several times, and nothing new installed in the interim because of the hope that we can do something better.

Mr. GORE. The best becomes the enemy of the better.

Mr. BURNETT. That is correct. I think that is something that this committee, it would be very helpful if you would address in the course of your hearings.

Mr. GORE. With specific regard to weather, would you recommend that the FAA make weather conditions and weather-related problems a much higher priority?

Mr. BURNETT. Yes, we certainly would.

Mr. Laynor, you will join me in that comment?

Mr. LAYNOR. Yes, I think so. Well, as Chairman Burnett indicated, it is a significant factor in well over half the air carrier accidents and a considerable number of the general aviation accidents. Addressing that problem on a high priority will have a major effect on the accident record. We continue to believe that operational limitations have to be applied so that you use the weather information. I think this is our biggest observation of the problem.

Mr. GORE. Well, very good. We have a number of other questions. Would you be prepared to answer some in writing for the record?

Mr. BURNETT. Certainly, Mr. Chairman.

Mr. GORE. Because of your time constraints we will let you go at this time with our thanks for the job you are doing and for your excellent testimony here. Thank you very much.

Mr. BURNETT. Thank you.

Mr. GORE. To our next panel of witnesses, let me explain to you what is going on. We have a vote on the floor. Chairman Glickman is on his way back. We may have to, in fact, I think we will adjourn very briefly, recess very briefly while he is on his way back.

When I say briefly I mean that, I don't think that it is going to take more than 2 or 3 or 4 minutes before he comes back. In the meantime, if our next witness would make his way to the witness table, Michael J. Fenello, Deputy Administrator of the Federal Aviation Administration, accompanied by several of your colleagues.

We will stand in brief recess and will come back in session when Chairman Glickman returns.

[Recess.]

Mr. GLICKMAN. I will have to apologize to the witnesses. We may be playing a cat and mouse game today to insure that we don't have much delay when we have rollcall votes.

Mr. Fenello, I don't know if you had begun your testimony or not, but it is a pleasure to have you here. This subcommittee held hearings last year in Los Angeles on the issue of aircraft collision avoidance systems on which you testified. I know because of your many years of experience in the aviation industry that your testimony will be quite useful to us.

Please proceed. As Mr. Gore indicated, your testimony, as with all the witnesses' prepared statements, will be included in the record in their entirety. So if you wish to summarize, you may do so.

STATEMENT OF MICHAEL J. FENELLO, DEPUTY ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION, ACCOMPANIED BY RAMON A. ALVAREZ, DEPUTY DIRECTOR, AIR TRAFFIC SERVICE; AL ALBRECHT, ASSOCIATE ADMINISTRATOR FOR ENGINEERING AND DEVELOPMENT; AND WALTER S. LUFFSEY, ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS

Mr. FENELLO. Thank you, Mr. Chairman. I welcome the opportunity to appear before you to discuss FAA's weather responsibilities and weather-related programs. With me today are Al Albrecht, Associate Administrator for Engineering and Development; Walt Luffsey, Associate Administrator for Aviation Standards; and Ray Alvarez, Deputy Director of the Air Traffic Service.

The Federal Aviation Administration's responsibility for aviation safety requires that accurate and current weather data be provided for the use in flight planning and to assist in realizing a safe and efficient air traffic flow. In fulfilling this responsibility, FAA and the National Weather Service of the Commerce Department's National Oceanic and Atmospheric Administration cooperate, by agreement, in the collection and dissemination of aviation weather. Essentially, NWS collects pertinent meteorological data and prepares forecasts and warnings which, in turn, the FAA distributes for the use of our air traffic personnel and pilots.

Fundamental to the operation of the ATC system is a pilot's direct responsibility for the safe operation of his aircraft. FAA regulations require that each pilot be familiar with weather reports and forecasts pertinent to the route of flight. FAA's responsibility to manage the Nation's airspace requires that all current weather and airport condition information which may affect flight is available to pilots and the air traffic control system.

Our controllers and specialists are required to familiarize themselves with pertinent weather information when reporting for duty and throughout their workday. Controllers are also required to issue specific weather information to all arrival and departure aircraft when certain weather conditions exist. If weather conditions such as low level wind shear or poor runway visibility exist, weather alerts must be issued to pilots. These procedures are designed to aid pilots in fulfilling their weather-related responsibilities.

As an additional service to pilots, flight service specialists provide requested weather information by face-to-face, telephone, or radio briefings. Our specialists also broadcast weather information over the voice channel feature of navigational aids. Aircraft are also provided with current weather advisories while en route to their destination. Additionally, pilots can access weather data provided by several mass weather dissemination techniques. Prerecorded information is available through telephone, pilot automatic telephone weather answering service, radio, transcribed weather broadcast, and automatic terminal information service.

FAA shares the concern of the aviation community of the need for further improvements in the collection and dissemination of weather information, and has accelerated several ongoing weather programs since 1977. One of these was the establishment of 21 weather service units in our air route traffic control centers as a result of a program implemented in 1978 to improve the quality,

quantity, and the operational significance of weather information made available to the center. Composed of a National Weather Service meteorologist and FAA weather coordinators, the center weather service units function as a team to detect, screen, and insure the timely dissemination of aviation weather information to affected areas both within and outside of the center.

Through analysis and interpretation of weather data to determine actual weather conditions, these weather specialists can provide "now casting"—a current detailed description of existing conditions—or diagnose a given situation to assist in making operational decisions; for instance, a sooner-than-expected development of thunderstorms or the beginning of snow or rain when none was expected. Thus, ATC personnel are advised of changing weather conditions and provided with updated forecasts. This program has proven to be highly successful. Early evaluations uncovered some problems in the collection and dissemination of selected weather products. To eliminate this problem, we are installing a faster communications network to replace older, slower teletypewriters. These improvements will provide the center weather service unit meteorologist with additional and more timely weather data.

The ATC system also receives information from the Weather Service's severe storms forecast center in Kansas City. "Sigmets," which are reports of significant meteorological information, such as strong frontal activity, moderate to heavy icing, wind shear, and the like, are distributed by the severe storms center to our air route traffic control centers and flight service stations. The information, in turn, is disseminated to affected controllers within the center and outlying terminal facilities by the center weather service unit for internal planning and relay to pilots through briefings, en route advisories, or transcribed broadcasts.

Additional efforts directed toward improvements in weather dissemination include operational changes, installation of new off-the-shelf equipment, and research and development activities.

Examples: Pilot weather briefings. We are revising our pilot weather briefing procedures to tailor the information to the requester's needs. Thus, requested or required data will be provided based on the type of aircraft, type of flight, pilot qualifications, and the previous weather data the pilot has received.

Flight service station automation: The FAA is in the second year of a 10-year FSS modernization program that, by automating much of the data retrieval and presentation, will enhance the timeliness and quality of weather information provided to the aviation community.

Digitized weather radar data and graphic charts, a nationwide file of pilot reports, and data from surface weather reporting stations will be available to flight service specialists and pilots.

Initial equipment deliveries for the first stage of automation—for the specialist—are expected late this year. The second stage of automation, which includes pilot direct access and the new FSS facilities, will be introduced in mid-fiscal year 1984. Pilots will then be able to directly access aeronautical and meteorological data essential to the safety of flight through telephone lines with user owned/operated communications data terminals.

A closely related program, which is planned as part of future FSS automation enhancements, is the aviation route forecast system. This system will automatically provide an improved method for describing existing and forecast area and en route weather. In addition to the standard weather information, the aviation route forecast briefing provides departure, destination, and en route Notam's; current weather synopsis; density altitude at departure airport; hourly surface observations; terminal forecasts, a digitized radar summary; and winds and temperature aloft.

Weather dissemination to pilots in flight: Once the pilot is airborne, the method of access to weather data is changed. Unless the aircraft has airborne weather radar—which all air carriers are required to have, but few general aviation aircraft have, unfortunately—the primary source for weather information is by voice contact with an air traffic controller or a flight service station specialist. The improvements in weather dissemination to airborne pilots that will result from the flight service station modernization program have already been reviewed. A description of other programs, planned or underway, for improving weather information for all users of the national airspace system includes:

High altitude en route flight advisory service: A separate radio frequency for high altitude en route flight advisory service is being implemented to eliminate frequency congestion and enhance aviation safety by providing high altitude aircraft with timely and meaningful advisories.

Radar remote weather display system: By early 1983, the center weather service units and 44 en route flight advisory service positions will have rapid access to both National Weather Service and to FAA radar weather data. The radar remote weather display system will be able to access six levels of precipitation intensity data from 134 radars nationwide. The network is composed of 57 FAA long-range radars and 77 National Weather Service weather radars. By 1985, radar remote weather display system data, in the form of contours presented on color displays, will be available to the center meteorologist.

Cockpit display of ground weather radar information: In the past 2 years, the agency has demonstrated a technique for providing weather radar data into the cockpit of general aviation aircraft. Using the Columbus, Ohio, weather radar, a small ground processor, the Zanesville very high frequency omnirange—VOR—station, an onboard microcomputer, which is interfaced to the VOR receiver and an inexpensive printer in the cockpit, we have transmitted a map of weather radar intensity data directly to a test aircraft operating within 75 miles of the VOR. The location of VOR sites within the map area is provided to permit the pilot to orient himself in relation to the weather system. The FAA is now in the process of evaluating the system and is planning a demonstration of the concept during the spring and summer of 1983.

Center weather processor: A three-phase effort to improve the quality, quantity, and operational significance of weather information is envisioned by the center weather processor/service unit automation program. This project is in the final stages of review. In the first phase—1986 and 1987—nearly all the manual operations now performed by the center weather service unit meteor-

ologist would be automated. We would also interconnect the center weather service unit work station with the radar remote weather display system, the flight service station data processor, and the National Airspace Data Interchange Network.

In the second phase of the program—1988 and 1989—data from the radar remote weather display system could be mosaicked and processed to provide hazardous weather contours to en route controllers who, in turn, could assist airborne pilots in hazardous weather avoidance. By the end of phase III—1992—the remote radar weather display system data would be replaced by the next generation weather radar data supplemented in the terminal area with data from FAA airport surveillance radars. The center weather processor/center weather service unit would be linked to controller sector suites in both en route and terminal control facilities. Mode "S" data link would become a primary link to the pilot receiving information from the center weather processor.

Automated surface weather observation: FAA is proceeding with automating the surface observation function. This will permit lowering approach minimums at some instrument landing system-equipped airports and a reduction in the cost of obtaining weather observations. Observations will be automatically broadcast over the FAA's network of VOR's and other selected voice frequencies and will be updated every several minutes. An operational demonstration of this system will begin this fall at airports in the Continental United States and Alaska.

Surveillance radar weather channels: FAA surveillance radars are optimized for aircraft target detection. Use of an existing spare receiver channel in our terminal radars, to bypass weather suppression circuits, will permit generation and display of six levels of precipitation intensity on a terminal controller's radar display.

Next generation weather radar [Nexrad]: Since the early 1970's, the FAA has sponsored research and development to determine the contribution Doppler weather radar technology can make to improved detection of hazardous weather phenomena. Since 1978, the FAA has joined with NWS and DOD, both of whom have a need to replace weather radars dating back to the 1950's, in a project at the national severe storms laboratory in Oklahoma to utilize Doppler technology. Results analyzed have shown a significant increase in the detection of hazards, including turbulence, wind shear, hail, and heavy precipitation, was possible using Doppler technology. Early detection through the use of processing to automatically perform hazard signature recognition will significantly aid meteorologists in identifying and predicting hazardous weather events.

In 1979, FAA joined with the Departments of Commerce and Defense to form a joint Special Program Office which is managed by the National Weather Service. FAA and DOD personnel are assigned to that office to assist the program manager in developing the next generation weather radar system.

Designs for the next generation weather radar, developed by three contractors, were received in June of this year, and technical requirements for the new radar are being finalized based on this work. The contract award for the validation phase of the program is scheduled for June 1983. Nationwide implementation would be

scheduled to start in the late 1980s and would be completed during 1990.

Airborne Doppler weather radar: In a parallel effort, the FAA is also evaluating airborne Doppler radar equipment. The program is currently comparing Doppler data taken on the ground at the National Severe Storms Laboratory with airborne Doppler data. The results of this program will be available in 1983.

Approach and landing: Prior to approach and landing, the pilot receives weather and terminal information, either by voice from the tower controller or from the automated terminal information system. Current surface weather observations are put on a voice tape along with other airport operating data by a controller. Since placing information on the tapes is a manual operation, keeping the information on weather current during rapidly changing conditions becomes a labor-intensive process. Within the past year, the automation of the task of reporting the latest weather observations via the automated terminal information system has been demonstrated at the Buffalo, N.Y., airport. Development of this concept will continue in 1983.

Joint airport weather studies: In a joint program with the National Science Foundation, the National Oceanic and Atmospheric Administration, and the National Aeronautics and Space Administration, severe weather data is currently being collected at Denver, Colo. The Denver area is an ideal setting in which to study downburst and microburst wind shear conditions associated with thunderstorm activity. Data analyses and studies will continue on the joint airport weather studies data through 1984. Research findings from this program are used to improve forecasting of severe weather phenomena and in design of new systems, such as Nexrad.

Wind shear detection: Since 1975, FAA has been investigating three areas for possible solutions: First, improved forecasting and prediction; second, ground-based sensors; and third, airborne techniques.

First, forecasting and prediction: Working closely with the National Weather Service and the National Severe Storms Laboratory, improvements were developed and implemented in the forecasting of frontal wind shears. These forecasts are currently made by the National Weather Service local forecast offices as conditions require. These offices are now able to predict shear conditions associated with cold fronts. Forecasts of this type are included in Sigmet warnings. While we are still not able to predict accurately shear condition associated with thunderstorms, this type of forecasting will be greatly improved by the development and implementation of the Nexrad system.

Second, ground-based sensors: We have developed a low level wind shear alert system which uses anemometers about the airport perimeter in conjunction with a central processor to detect wind shear conditions at the airport. This system is triggered by a 15-knot wind vector differential between perimeter anemometers and a center field anemometer. This system, while limited to measuring only surface wind phenomena, does provide a significant measure of protection within the landing and takeoff zones. To date, a total of 58 systems have been installed. Pending the outcome of congressional actions on FAA authorizations and appropriations, current

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planning is for 51 additional systems to be operational by the end of 1985.

I might observe here that authorization by this committee has always been timely and responsive to our needs. In addition to the ground systems which have been implemented, we are continuing activities in the area of sensor research to develop sensors suitable for detection of wind-shear conditions in the approach and departure corridors.

Mr. GLICKMAN. Excuse me. Your statement says the additional systems will be operational by the end of 1984. Did you mean 1984 or 1985 in your testimony?

Mr. FENELLO. 1985. It would be late in 1984 so we might as well use 1985.

Third, airborne flight simulations to evaluate airborne devices for the detection and display of wind-shear information in the cockpit have been conducted for transport category aircraft over the past several years. Shear profiles and procedures for operating in wind-shear conditions have been developed and distributed to the airlines for use in pilot training programs. And I know for a fact that these are being used in their ground school programs and in their simulator programs, and they are proving to be very effective. We have had cases in recent history where it has been demonstrated in real life.

This might sound like I am taking a little time to go through much of what has been going on, but I guess if we followed the press and some of the statements that are made in and outside the committee, a perception might be obtained out there that very little is happening in the FAA. But a lot is happening in the FAA. And I prefer to walk through some of this just for the record.

Prototype regional serving and forecasting system. FAA has also sponsored work with NOAA's prototype regional observing and forecasting system located at Boulder, Colo. Weather products are generated from weather sensors located within a 100-by-100-kilometer grid centered over Boulder. Special observations are taken at frequent intervals with sensors that are jointly used for this as well as other research efforts.

The program intent is to provide the information needed to automate the analysis of inputs from automated surface weather observations, doppler and conventional weather radars, special microwave upper air wind measuring equipment, and visible or infrared satellite data to produce a variety of new weather products. As products become available, they are sent, on a test basis, to the center weather service unit meteorologist in the Denver Air Route Traffic Control Center for evaluation. Information derived from these tests will be used in the development of the specification of the Automated Center Weather Service Unit workstation. This program will continue through 1985.

And finally the national airspace review. The FAA, along with 16 task groups of aviation users, has undertaken a review of the use of the Nation's airspace and the procedural aspects of the air traffic control system. Included in this effort, of which I am chairman, is a task force to review the timely dissemination of real-time weather. That task group has recently completed an intensive study of this topic. Their report should be finalized later this year.

We will be looking very closely at their recommendations and anticipate that there will be further improvements pursued in addition to those specifically identified here today.

In conclusion, FAA has placed a high priority on improvement in the sensing, processing, and dissemination of weather information. Automation of the process of taking and processing observations will significantly improve the quality and timeliness of weather information. Introduction of data link services on both the VOR and Mode S systems will provide timely graphic and alphanumeric weather data to the pilot.

Implementation of wind-shear systems in the operational environment is providing controllers and pilots with timely warnings on this hazard. Implementation of the next-generation weather radar network, utilization of weather channels on terminal radars, and automation of the center weather service unit and flight service station functions will provide real-time graphic outputs of identified severe-weather hazards to pilots and controllers. FAA has embarked on a comprehensive program to improve the weather system and plans to invest approximately $700 million in development and implementation of efforts associated with the weather program in this decade. These programs are expected to improve aviation safety significantly by improving weather information available to users of the national airspace system.

That concludes my prepared statement, Mr. Chairman. At this time, my associates who, as you know, are experts in their respective areas and have a specific responsibility in the weather areas, will be pleased to respond to questions you might have.

[The prepared statement of Mr. Fenello follows:]

STATEMENT OF THE HONORABLE MICHAEL J. FENELLO,
DEPUTY FEDERAL AVIATION ADMINISTRATOR, BEFORE THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEES ON TRANSPORTATION, AVIATION AND MATERIALS,
AND INVESTIGATIONS AND OVERSIGHT,
CONCERNING AVIATION WEATHER

AUGUST 11, 1982

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEES:

I WELCOME THE OPPORTUNITY TO APPEAR BEFORE YOU TO DISCUSS FAA'S WEATHER RESPONSIBILITIES AND WEATHER-RELATED PROGRAMS. WITH ME TODAY ARE AL ALBRECHT, ASSOCIATE ADMINISTRATOR FOR ENGINEERING AND DEVELOPMENT; WALT LUFFSEY, ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS; AND RAY ALVAREZ, DEPUTY DIRECTOR OF THE AIR TRAFFIC SERVICE.

THE FEDERAL AVIATION ADMINISTRATION'S RESPONSIBILITY FOR AVIATION SAFETY REQUIRES THAT ACCURATE AND CURRENT WEATHER DATA BE PROVIDED FOR THE USE IN FLIGHT PLANNING AND TO ASSIST IN REALIZING A SMOOTH AND EFFICIENT AIR TRAFFIC FLOW. IN FULFILLING THIS RESPONSIBILITY, FAA AND THE NATIONAL WEATHER SERVICE OF THE COMMERCE DEPARTMENT'S NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION COOPERATE, BY AGREEMENT, IN THE COLLECTION AND DISSEMINATION OF AVIATION WEATHER. ESSENTIALLY, NWS COLLECTS PERTINENT METEOROLOGICAL DATA AND PREPARES FORECASTS AND WARNINGS WHICH, IN TURN, THE FAA DISTRIBUTES FOR THE USE OF OUR AIR TRAFFIC PERSONNEL AND PILOTS.

FUNDAMENTAL TO THE OPERATION OF THE ATC SYSTEM IS A PILOT'S DIRECT RESPONSIBILITY FOR THE SAFE OPERATION OF HIS AIRCRAFT. FAA REGULATIONS REQUIRE THAT EACH PILOT BE FAMILIAR WITH WEATHER REPORTS AND FORECASTS PERTINENT TO THE ROUTE OF FLIGHT. FAA'S RESPONSIBILITY TO MANAGE THE NATION'S AIRSPACE REQUIRES THAT ALL CURRENT WEATHER AND AIRPORT CONDITION INFORMATION WHICH MAY AFFECT FLIGHT IS AVAILABLE TO PILOTS AND THE AIR TRAFFIC CONTROL SYSTEM.

OUR CONTROLLERS AND SPECIALISTS ARE REQUIRED TO FAMILIARIZE THEMSELVES WITH PERTINENT WEATHER INFORMATION WHEN REPORTING FOR DUTY AND THROUGHOUT THEIR WORKDAY. CONTROLLERS ARE ALSO REQUIRED TO ISSUE SPECIFIC WEATHER INFORMATION TO ALL ARRIVAL AND DEPARTURE AIRCRAFT WHEN CERTAIN WEATHER CONDITIONS EXIST. IF WEATHER CONDITIONS SUCH AS LOW LEVEL WIND SHEAR OR POOR RUNWAY VISIBILITY EXIST, WEATHER ALERTS MUST BE ISSUED TO PILOTS. THESE PROCEDURES ARE DESIGNED TO AID PILOTS IN FULFILLING THEIR WEATHER-RELATED RESPONSIBILITIES.

AS AN ADDITIONAL SERVICE TO PILOTS, FLIGHT SERVICE SPECIALISTS PROVIDE REQUESTED WEATHER INFORMATION BY FACE-TO-FACE, TELEPHONE, OR RADIO BRIEFINGS. OUR SPECIALISTS ALSO BROADCAST WEATHER INFORMATION OVER THE VOICE CHANNEL FEATURE OF NAVIGATIONAL AIDS. AIRCRAFT ARE ALSO PROVIDED WITH CURRENT WEATHER ADVISORIES WHILE EN ROUTE TO THEIR DESTINATION. ADDITIONALLY, PILOTS CAN ACCESS WEATHER DATA PROVIDED BY SEVERAL MASS WEATHER DISSEMINATION

TECHNIQUES. PRERECORDED INFORMATION IS AVAILABLE THROUGH TELEPHONE, PILOT AUTOMATIC TELEPHONE WEATHER ANSWERING SERVICE (PATWAS), RADIO, TRANSCRIBED WEATHER BROADCAST (TWEB), AND AUTOMATIC TERMINAL INFORMATION SERVICE (ATIS).

FAA SHARES THE CONCERN OF THE AVIATION COMMUNITY OF THE NEED FOR FURTHER IMPROVEMENTS IN THE COLLECTION AND DISSEMINATION OF WEATHER INFORMATION, AND HAS ACCELERATED SEVERAL ONGOING WEATHER PROGRAMS SINCE 1977. ONE OF THESE WAS THE ESTABLISHMENT OF TWENTY-ONE WEATHER SERVICE UNITS IN OUR AIR ROUTE TRAFFIC CONTROL CENTERS AS A RESULT OF A PROGRAM IMPLEMENTED IN 1978 TO IMPROVE THE QUALITY, QUANTITY, AND THE OPERATIONAL SIGNIFICANCE OF WEATHER INFORMATION MADE AVAILABLE TO THE CENTER. COMPOSED OF A NATIONAL WEATHER SERVICE METEOROLOGIST AND FAA WEATHER COORDINATORS, THE CENTER WEATHER SERVICE UNITS FUNCTION AS A TEAM TO DETECT, SCREEN, AND ENSURE THE TIMELY DISSEMINATION OF AVIATION WEATHER INFORMATION TO AFFECTED AREAS BOTH WITHIN AND OUTSIDE OF THE CENTER.

THROUGH ANALYSIS AND INTERPRETATION OF WEATHER DATA TO DETERMINE ACTUAL WEATHER CONDITIONS, THESE WEATHER SPECIALISTS CAN PROVIDE "NOW CASTING"--A CURRENT DETAILED DESCRIPTION OF EXISTING CONDITIONS--OR DIAGNOSE A GIVEN SITUATION TO ASSIST IN MAKING OPERATIONAL DECISIONS; FOR INSTANCE, A SOONER-THAN-EXPECTED DEVELOPMENT OF THUNDERSTORMS OR THE BEGINNING OF SNOW OR RAIN

WHEN NONE WAS EXPECTED. THUS, ATC PERSONNEL ARE ADVISED OF CHANGING WEATHER CONDITIONS AND PROVIDED WITH UPDATED FORECASTS. THIS PROGRAM HAS PROVEN TO BE HIGHLY SUCCESSFUL. EARLY EVALUATIONS UNCOVERED SOME PROBLEMS IN THE COLLECTION AND DISSEMINATION OF SELECTED WEATHER PRODUCTS. TO ELIMINATE THIS PROBLEM, WE ARE INSTALLING A FASTER COMMUNICATIONS NETWORK TO REPLACE OLDER, SLOWER TELETYPEWRITERS. THESE IMPROVEMENTS WILL PROVIDE THE CENTER WEATHER SERVICE UNIT METEOROLOGIST WITH ADDITIONAL AND MORE TIMELY WEATHER DATA.

THE ATC SYSTEM ALSO RECEIVES INFORMATION FROM THE WEATHER SERVICE'S SEVERE STORMS FORECAST CENTER IN KANSAS CITY. "SIGMETS," WHICH ARE REPORTS OF SIGNIFICANT METEOROLOGICAL INFORMATION, SUCH AS STRONG FRONTAL ACTIVITY, MODERATE TO HEAVY ICING, WIND SHEAR, ETC., ARE DISTRIBUTED BY THE SEVERE STORMS CENTER TO OUR AIR ROUTE TRAFFIC CONTROL CENTERS AND FLIGHT SERVICE STATIONS. THE INFORMATION, IN TURN, IS DISSEMINATED TO AFFECTED CONTROLLERS WITHIN THE CENTER AND OUTLYING TERMINAL FACILITIES BY THE CENTER WEATHER SERVICE UNIT FOR INTERNAL PLANNING AND RELAY TO PILOTS THROUGH BRIEFINGS, EN ROUTE ADVISORIES, OR TRANSCRIBED BROADCASTS.

ADDITIONAL EFFORTS DIRECTED TOWARD IMPROVEMENTS IN WEATHER DISSEMINATION INCLUDE OPERATIONAL CHANGES, INSTALLATION OF NEW OFF-THE-SHELF EQUIPMENT, AND RESEARCH AND DEVELOPMENT ACTIVITIES:

- PILOT WEATHER BRIEFINGS. WE ARE REVISING OUR PILOT WEATHER BRIEFING PROCEDURES TO TAILOR THE INFORMATION TO THE REQUESTOR'S NEEDS. THUS, REQUESTED OR REQUIRED DATA WILL BE PROVIDED BASED ON THE TYPE OF AIRCRAFT, TYPE OF FLIGHT, PILOT QUALIFICATIONS, AND THE PREVIOUS WEATHER DATA THE PILOT HAS RECEIVED.

- FLIGHT SERVICE STATION AUTOMATION. THE FAA IS IN THE SECOND YEAR OF A 10-YEAR FSS MODERNIZATION PROGRAM THAT, BY AUTOMATING MUCH OF THE DATA RETRIEVAL AND PRESENTATION, WILL ENHANCE THE TIMELINESS AND QUALITY OF WEATHER INFORMATION PROVIDED TO THE AVIATION COMMUNITY.

  DIGITIZED WEATHER RADAR DATA AND GRAPHIC CHARTS, A NATIONWIDE FILE OF PILOT REPORTS, AND DATA FROM SURFACE WEATHER REPORTING STATIONS WILL BE AVAILABLE TO FLIGHT SERVICE SPECIALISTS AND PILOTS.

  INITIAL EQUIPMENT DELIVERIES FOR THE FIRST STAGE OF AUTOMATION (FOR THE SPECIALIST) ARE EXPECTED LATE THIS YEAR. THE SECOND STAGE OF AUTOMATION, WHICH INCLUDES PILOT DIRECT ACCESS AND THE NEW FSS FACILITIES, WILL BE INTRODUCED IN MID-FY 1984. PILOTS WILL THEN BE ABLE TO DIRECTLY ACCESS AERONAUTICAL AND METEOROLOGICAL DATA ESSENTIAL TO THE SAFETY OF FLIGHT THROUGH TELEPHONE LINES WITH USER OWNED/OPERATED COMMUNICATIONS DATA TERMINALS.

A CLOSELY RELATED PROGRAM, WHICH IS PLANNED AS PART OF FUTURE FSS AUTOMATION ENHANCEMENTS, IS THE AVIATION ROUTE FORECAST SYSTEM. THIS SYSTEM WILL AUTOMATICALLY PROVIDE AN IMPROVED METHOD FOR DESCRIBING EXISTING AND FORECAST AREA AND EN ROUTE WEATHER. IN ADDITION TO THE STANDARD WEATHER INFORMATION, THE AVIATION ROUTE FORECAST BRIEFING PROVIDES DEPARTURE, DESTINATION, AND EN ROUTE NOTAM'S; CURRENT WEATHER SYNOPSIS; DENSITY ALTITUDE AT DEPARTURE AIRPORT; HOURLY SURFACE OBSERVATIONS; TERMINAL FORECASTS, A DIGITIZED RADAR SUMMARY; AND WINDS AND TEMPERATURE ALOFT.

- WEATHER DISSEMINATION TO PILOTS IN FLIGHT. ONCE THE PILOT IS AIRBORNE, THE METHOD OF ACCESS TO WEATHER DATA IS CHANGED. UNLESS THE AIRCRAFT HAS AIRBORNE WEATHER RADAR (WHICH ALL AIR CARRIERS ARE REQUIRED TO HAVE, BUT FEW GENERAL AVIATION AIRCRAFT HAVE), THE PRIMARY SOURCE FOR WEATHER INFORMATION IS BY VOICE CONTACT WITH AN AIR TRAFFIC CONTROLLER OR A FLIGHT SERVICE STATION SPECIALIST. THE IMPROVEMENTS IN WEATHER DISSEMINATION TO AIRBORNE PILOTS THAT WILL RESULT FROM THE FLIGHT SERVICE STATION MODERNIZATION PROGRAM HAVE ALREADY BEEN REVIEWED. A DESCRIPTION OF OTHER PROGRAMS, PLANNED OR UNDERWAY, FOR IMPROVING WEATHER INFORMATION FOR ALL USERS OF THE NATIONAL AIRSPACE SYSTEM INCLUDES:

- HIGH ALTITUDE EN ROUTE FLIGHT ADVISORY SERVICE (EFAS): A SEPARATE RADIO FREQUENCY FOR HIGH ALTITUDE EN ROUTE FLIGHT ADVISORY SERVICE IS BEING IMPLEMENTED TO ELIMINATE FREQUENCY CONGESTION AND ENHANCE AVIATION SAFETY BY PROVIDING HIGH ALTITUDE AIRCRAFT WITH TIMELY AND MEANINGFUL ADVISORIES.

- RADAR REMOTE WEATHER DISPLAY SYSTEM. BY EARLY 1983, THE CENTER WEATHER SERVICE UNITS AND 44 EN ROUTE FLIGHT ADVISORY SERVICE POSITIONS WILL HAVE BOTH RAPID ACCESS TO NATIONAL WEATHER SERVICE AND FAA RADAR WEATHER DATA. THE RADAR REMOTE WEATHER DISPLAY SYSTEM WILL BE ABLE TO ACCESS SIX LEVELS OF PRECIPITATION INTENSITY DATA FROM 134 RADARS NATIONWIDE. THE NETWORK IS COMPOSED OF 57 FAA LONG RANGE RADARS AND 77 NWS WEATHER RADARS. BY 1985, RADAR REMOTE WEATHER DISPLAY SYSTEM DATA, IN THE FORM OF CONTOURS PRESENTED ON COLOR DISPLAYS, WILL BE AVAILABLE TO THE CENTER METEOROLOGIST.

- COCKPIT DISPLAY OF GROUND WEATHER RADAR INFORMATION. IN THE PAST 2 YEARS, THE AGENCY HAS DEMONSTRATED A TECHNIQUE FOR PROVIDING WEATHER RADAR DATA INTO THE COCKPIT OF GENERAL AVIATION AIRCRAFT. USING THE COLUMBUS, OHIO, WEATHER RADAR, A SMALL GROUND PROCESSOR, THE ZANESVILLE VERY HIGH FREQUENCY OMNI-RANGE (VOR) STATION, AN ON-BOARD MICRO-COMPUTER, WHICH IS INTERFACED TO THE VOR RECEIVER

AND AN INEXPENSIVE PRINTER IN THE COCKPIT, WE HAVE TRANSMITTED A MAP OF WEATHER RADAR INTENSITY DATA DIRECTLY TO A TEST AIRCRAFT OPERATING WITHIN 75 MILES OF THE VOR. THE LOCATION OF VOR SITES WITHIN THE MAP AREA IS PROVIDED TO PERMIT THE PILOT TO ORIENT HIMSELF IN RELATION TO THE WEATHER SYSTEM. THE FAA IS NOW IN THE PROCESS OF EVALUATING THE SYSTEM AND IS PLANNING A DEMONSTRATION OF THE CONCEPT DURING THE SPRING AND SUMMER OF 1983.

CENTER WEATHER PROCESSOR. A THREE-PHASE EFFORT TO IMPROVE THE QUALITY, QUANTITY, AND OPERATIONAL SIGNIFICANCE OF WEATHER INFORMATION IS ENVISIONED BY THE CENTER WEATHER PROCESSOR/SERVICE UNIT AUTOMATION PROGRAM. THIS PROJECT IS IN THE FINAL STAGES OF REVIEW. IN THE FIRST PHASE (1986 AND 1987), NEARLY ALL THE MANUAL OPERATIONS NOW PERFORMED BY THE CENTER WEATHER SERVICE UNIT METEOROLOGIST WOULD BE AUTOMATED. WE WOULD ALSO INTERCONNECT THE CENTER WEATHER SERVICE UNIT WORKSTATION WITH THE RADAR REMOTE WEATHER DISPLAY SYSTEM, THE FLIGHT SERVICE STATION DATA PROCESSOR, AND THE NATIONAL AIRSPACE DATA INTERCHANGE NETWORK. IN THE SECOND PHASE OF THE PROGRAM (1988 AND 1989), DATA FROM THE RADAR REMOTE WEATHER DISPLAY SYSTEM COULD BE MOSAICKED AND PROCESSED TO PROVIDE HAZARDOUS WEATHER CONTOURS TO EN ROUTE CONTROLLERS TO ASSIST AIRBORNE PILOTS IN HAZARDOUS WEATHER AVOIDANCE. BY THE END OF PHASE III (1992), THE REMOTE RADAR WEATHER DISPLAY SYSTEM DATA WOULD BE REPLACED

BY THE NEXT GENERATION WEATHER RADAR DATA SUPPLEMENTED IN THE TERMINAL AREA WITH DATA FROM FAA AIRPORT SURVEILLANCE RADARS. THE CENTER WEATHER PROCESSOR/CENTER WEATHER SERVICE UNIT WOULD BE LINKED TO CONTROLLER SECTOR SUITES IN BOTH EN ROUTE AND TERMINAL CONTROL FACILITIES. MODE S DATA LINK WOULD BECOME A PRIMARY LINK TO THE PILOT RECEIVING INFORMATION FROM THE CENTER WEATHER PROCESSOR.

- AUTOMATED SURFACE WEATHER OBSERVATION. FAA IS PROCEEDING WITH AUTOMATING THE SURFACE OBSERVATION FUNCTION. THIS WILL PERMIT LOWERING APPROACH MINIMUMS AT SOME INSTRUMENT LANDING SYSTEM-EQUIPPED AIRPORTS AND A REDUCTION IN THE COST OF OBTAINING WEATHER OBSERVATIONS. OBSERVATIONS WILL BE AUTOMATICALLY BROADCAST OVER THE FAA'S NETWORK OF VOR'S AND OTHER SELECTED VOICE FREQUENCIES AND WILL BE UPDATED EVERY SEVERAL MINUTES. AN OPERATIONAL DEMONSTRATION OF THIS SYSTEM WILL BEGIN THIS FALL AT AIRPORTS IN THE CONTINENTAL UNITED STATES AND ALASKA.

- SURVEILLANCE RADAR WEATHER CHANNELS. FAA SURVEILLANCE RADARS ARE OPTIMIZED FOR AIRCRAFT TARGET DETECTION. USE OF AN EXISTING SPARE RECEIVER CHANNEL IN OUR TERMINAL

RADARS, TO BYPASS WEATHER SUPPRESSION CIRCUITS, WILL PERMIT GENERATION AND DISPLAY OF SIX LEVELS OF PRECIPITATION INTENSITY ON A TERMINAL CONTROLLER'S RADAR DISPLAY.

NEXT GENERATION WEATHER RADAR (NEXRAD). SINCE THE EARLY 1970'S, THE FAA HAS SPONSORED RESEARCH AND DEVELOPMENT TO DETERMINE THE CONTRIBUTION DOPPLER WEATHER RADAR TECHNOLOGY CAN MAKE TO IMPROVED DETECTION OF HAZARDOUS WEATHER PHENOMENA. SINCE 1978, THE FAA HAS JOINED WITH NWS AND DOD, BOTH OF WHOM HAVE A NEED TO REPLACE WEATHER RADARS DATING BACK TO THE 1950'S, IN A PROJECT AT THE NATIONAL SEVERE STORMS LABORATORY IN OKLAHOMA TO UTILIZE DOPPLER TECHNOLOGY. RESULTS ANALYZED HAVE SHOWN A SIGNIFICANT INCREASE IN DETECTION OF HAZARDS, INCLUDING TURBULENCE, WIND SHEAR, HAIL, AND HEAVY PRECIPITATION, WAS POSSIBLE USING DOPPLER TECHNOLOGY. EARLY DETECTION THPOUGH THE USE OF PROCESSING TO AUTOMATICALLY PERFORM HAZARD SIGNATURE RECOGNITION WILL SIGNIFICANTLY AID METEOROLOGISTS IN IDENTIFYING AND PREDICTING HAZARDOUS WEATHER EVENTS.

IN 1979, FAA JOINED WITH THE DEPARTMENTS OF COMMERCE AND DEFENSE TO FORM A JOINT SPECIAL PROGRAM OFFICE WHICH IS

MANAGED BY THE NATIONAL WEATHER SERVICE. FAA AND DOD PERSONNEL ARE ASSIGNED TO THAT OFFICE TO ASSIST THE PROGRAM MANAGER IN DEVELOPING THE NEXT GENERATION WEATHER RADAR SYSTEM.

DESIGNS FOR THE NEXT GENERATION WEATHER RADAR, DEVELOPED BY THREE CONTRACTORS, WERE RECEIVED IN JUNE, AND TECHNICAL REQUIREMENTS FOR THE NEW RADAR ARE BEING FINALIZED BASED ON THIS WORK. THE CONTRACT AWARD FOR THE VALIDATION PHASE OF THE PROGRAM IS SCHEDULED FOR JUNE 1983. NATIONWIDE IMPLEMENTATION WOULD BE SCHEDULED TO START IN 1987 AND WOULD BE COMPLETED DURING 1990.

- AIRBORNE DOPPLER WEATHER RADAR. IN A PARALLEL EFFORT, THE FAA IS ALSO EVALUATING AIRBORNE DOPPLER RADAR EQUIPMENT. THE PROGRAM IS CURRENTLY COMPARING DOPPLER DATA TAKEN ON THE GROUND AT THE NATIONAL SEVERE STORMS LABORATORY WITH AIRBORNE DOPPLER DATA. THE RESULTS OF THIS PROGRAM WILL BE AVAILABLE IN 1983.

- APPROACH AND LANDING. PRIOR TO APPROACH AND LANDING, THE PILOT RECEIVES WEATHER AND TERMINAL INFORMATION, EITHER BY VOICE FROM THE TOWER CONTROLLER OR FROM THE AUTOMATED TERMINAL INFORMATION SYSTEM. CURRENT SURFACE WEATHER OBSERVATIONS ARE PUT ON A VOICE TAPE ALONG WITH OTHER AIRPORT

OPERATING DATA BY A CONTROLLER. SINCE PLACING INFORMATION ON THE TAPES IS A MANUAL OPERATION, KEEPING THE INFORMATION ON WEATHER CURRENT DURING RAPIDLY CHANGING CONDITIONS BECOMES A LABOR-INTENSIVE PROCESS. WITHIN THE PAST YEAR, THE AUTOMATION OF THE TASK OF REPORTING THE LATEST WEATHER OBSERVATIONS VIA THE AUTOMATED TERMINAL INFORMATION SYSTEM HAS BEEN DEMONSTRATED AT THE BUFFALO, NEW YORK, AIRPORT. DEVELOPMENT OF THIS CONCEPT WILL CONTINUE IN 1983.

- JOINT AIRPORT WEATHER STUDIES. IN A JOINT PROGRAM WITH THE NATIONAL SCIENCE FOUNDATION, THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, DATA IS CURRENTLY BEING COLLECTED AT DENVER, COLORADO. THE DENVER AREA IS AN IDEAL SETTING IN WHICH TO STUDY DOWNBURST AND MICROBURST WIND SHEAR CONDITIONS ASSOCIATED WITH THUNDERSTORM ACTIVITY. DATA ANALYSES AND STUDIES WILL CONTINUE ON THE JOINT AIRPORT WEATHER STUDIES DATA THROUGH 1984. RESEARCH FINDINGS FROM THIS PROGRAM ARE USED TO IMPROVE FORECASTING OF SEVERE WEATHER PHENOMENA AND IN DESIGN OF NEW SYSTEMS, SUCH AS NEXRAD.

- WIND SHEAR DETECTION. SINCE 1975, FAA HAS BEEN INVESTIGATING THREE AREAS FOR POSSIBLE SOLUTIONS: (1) IMPROVED FORECASTING AND PREDICTION; (2) GROUND-BASED SENSORS; AND (3) AIRBORNE TECHNIQUES.

  (1) FORECASTING AND PREDICTION. WORKING CLOSELY WITH THE NATIONAL WEATHER SERVICE AND THE NATIONAL SEVERE STORMS

LABORATORY, IMPROVEMENTS WERE DEVELOPED AND IMPLEMENTED IN THE FORECASTING OF FRONTAL WIND SHEARS. THESE FORECASTS ARE CURRENTLY MADE BY THE NATIONAL WEATHER SERVICE LOCAL FORECAST OFFICES AS CONDITIONS REQUIRE. THESE OFFICES ARE NOW ABLE TO PREDICT SHEAR CONDITIONS ASSOCIATED WITH COLD FRONTS. FORECASTS OF THIS TYPE ARE INCLUDED IN SIGMET WARNINGS. WHILE WE ARE STILL NOT ABLE TO PREDICT ACCURATELY SHEAR CONDITIONS ASSOCIATED WITH THUNDERSTORMS, THIS TYPE OF FORECASTING WILL BE GREATLY IMPROVED BY THE DEVELOPMENT AND IMPLEMENTATION OF THE NEXRAD SYSTEM.

(2) GROUND-BASED SENSORS. WE HAVE DEVELOPED A LOW LEVEL WIND SHEAR ALERT SYSTEM WHICH USES ANEMOMETERS ABOUT THE AIRPORT PERIMETER IN CONJUNCTION WITH A CENTRAL PROCESSOR TO DETECT WIND SHEAR CONDITIONS AT THE AIRPORT. THIS SYSTEM IS TRIGGERED BY A 15 KNOT WIND VECTOR DIFFERENTIAL BETWEEN PERIMETER ANEMOMETERS AND A CENTER FIELD ANEMOMETER. THIS SYSTEM, WHILE LIMITED TO MEASURING ONLY SURFACE WIND PHENOMENA, DOES PROVIDE A SIGNIFICANT MEASURE OF PROTECTION WITHIN THE LANDING AND TAKEOFF ZONES. TO DATE, A TOTAL OF 58 SYSTEMS HAVE BEEN INSTALLED. PENDING THE OUTCOME OF CONGRESSIONAL ACTIONS ON FAA AUTHORIZATIONS AND APPROPRIATIONS, CURRENT PLANNING IS FOR 51 ADDITIONAL SYSTEMS TO BE OPERATIONAL BY THE END OF 1985. IN ADDITION TO THE GROUND

SYSTEMS WHICH HAVE BEEN IMPLEMENTED, WE ARE CONTINUING ACTIVITIES IN THE AREA OF SENSOR RESEARCH TO DEVELOP SENSORS SUITABLE FOR DETECTION OF WIND SHEAR CONDITIONS IN THE APPROACH AND DEPARTURE CORRIDORS.

(3) AIRBORNE. FLIGHT SIMULATIONS TO EVALUATE AIRBORNE DEVICES FOR THE DETECTION AND DISPLAY OF WIND SHEAR INFORMATION IN THE COCKPIT HAVE BEEN CONDUCTED FOR TRANSPORT CATEGORY AIRCRAFT OVER THE PAST SEVERAL YEARS. SHEAR PROFILES AND PROCEDURES FOR OPERATING IN WIND SHEAR CONDITIONS HAVE BEEN DEVELOPED AND DISTRIBUTED TO THE AIRLINES FOR USE IN PILOT TRAINING PROGRAMS.

- PROTOTYPE REGIONAL OBSERVING AND FORECASTING SYSTEM. FAA HAS ALSO SPONSORED WORK WITH NOAA'S PROTOTYPE REGIONAL OBSERVING AND FORECASTING SYSTEM LOCATED AT BOULDER, COLORADO. WEATHER PRODUCTS ARE GENERATED FROM WEATHER SENSORS LOCATED WITHIN A 100 KILOMETER BY 100 KILOMETER GRID CENTERED OVER BOULDER. SPECIAL OBSERVATIONS ARE TAKEN AT FREQUENT INTERVALS WITH SENSORS THAT ARE JOINTLY USED FOR THIS AS WELL AS OTHER RESEARCH EFFORTS. THE PROGRAM INTENT IS TO PROVIDE THE INFORMATION NEEDED TO AUTOMATE THE ANALYSIS OF INPUTS FROM AUTOMATED SURFACE WEATHER OBSERVATIONS, DOPPLER AND CONVENTIONAL WEATHER

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RADARS, SPECIAL MICROWAVE UPPER AIR WIND MEASURING EQUIPMENT, AND VISIBLE OR INFRARED SATELLITE DATA TO PRODUCE A VARIETY OF NEW WEATHER PRODUCTS. AS PRODUCTS BECOME AVAILABLE, THEY ARE SENT, ON A TEST BASIS, TO THE CENTER WEATHER SERVICE UNIT METEOROLOGIST IN THE DENVER AIR ROUTE TRAFFIC CONTROL CENTER FOR EVALUATION. INFORMATION DERIVED FROM THESE TESTS WILL BE USED IN THE DEVELOPMENT OF THE SPECIFICATION OF THE AUTOMATED CENTER WEATHER SERVICE UNIT WORKSTATION. THIS PROGRAM WILL CONTINUE THROUGH 1985.

AND FINALLY THE:

- NATIONAL AIRSPACE REVIEW. THE FAA, ALONG WITH 16 TASK GROUPS OF AVIATION USERS, HAS UNDERTAKEN A REVIEW OF THE USE OF THE NATION'S AIRSPACE AND THE PROCEDURAL ASPECTS OF THE AIR TRAFFIC CONTROL SYSTEM. INCLUDED IN THIS EFFORT, OF WHICH I AM CHAIRMAN, IS A TASK FORCE TO REVIEW THE TIMELY DISSEMINATION OF REAL-TIME WEATHER. THAT TASK GROUP HAS RECENTLY COMPLETED AN INTENSIVE STUDY OF THIS TOPIC. THEIR REPORT SHOULD BE FINALIZED LATER THIS YEAR. WE WILL BE LOOKING VERY CLOSELY AT THEIR RECOMMENDATIONS AND ANTICIPATE THAT THERE WILL BE FURTHER IMPROVEMENTS PURSUED IN ADDITION TO THOSE SPECIFICALLY IDENTIFIED HERE TODAY.

IN CONCLUSION, FAA HAS PLACED A HIGH PRIORITY ON IMPROVEMENT IN THE SENSING, PROCESSING, AND DISSEMINATION OF WEATHER INFORMATION. AUTOMATION OF THE PROCESS OF TAKING AND PROCESSING OBSERVATIONS WILL SIGNIFICANTLY IMPROVE THE QUALITY AND TIMELINESS OF WEATHER INFORMATION. INTRODUCTION OF DATA LINK SERVICES ON BOTH THE VOR AND MODE S SYSTEMS WILL PROVIDE TIMELY GRAPHIC AND ALPHANUMERIC WEATHER DATA TO THE PILOT. IMPLEMENTATION OF WIND SHEAR SYSTEMS IN THE OPERATIONAL ENVIRONMENT IS PROVIDING CONTROLLERS AND PILOTS WITH TIMELY WARNINGS ON THIS HAZARD. IMPLEMENTATION OF THE NEXT GENERATION WEATHER RADAR NETWORK, UTILIZATION OF WEATHER CHANNELS ON TERMINAL RADARS, AND AUTOMATION OF THE CENTER WEATHER SERVICE UNIT AND FLIGHT SERVICE STATION FUNCTIONS WILL PROVIDE REAL-TIME GRAPHIC OUTPUTS OF IDENTIFIED SEVERE WEATHER HAZARDS TO PILOTS AND CONTROLLERS. FAA HAS EMBARKED ON A COMPREHENSIVE PROGRAM TO IMPROVE THE WEATHER SYSTEM AND PLANS TO INVEST APPROXIMATELY $700 MILLION IN DEVELOPMENT AND IMPLEMENTATION EFFORTS ASSOCIATED WITH THE WEATHER PROGRAM IN THIS DECADE. THESE PROGRAMS ARE EXPECTED TO IMPROVE AVIATION SAFETY SIGNIFICANTLY BY IMPROVING WEATHER INFORMATION AVAILABLE TO USERS OF THE NATIONAL AIRSPACE SYSTEM.

THAT CONCLUDES MY PREPARED STATEMENT, MR. CHAIRMAN. AT THIS TIME, I WOULD BE PLEASED TO RESPOND TO ANY QUESTIONS YOU MIGHT HAVE.

Mr. GORE. Thank you, Mr. Fenello.

Chairman Glickman.

Mr. GLICKMAN. Mr. Fenello, first of all, I would like to read you something which appeared in the Washington Post of August 7 this year regarding the description of the wind shear at New Orleans Moisant Airport.

I am not going into the specifics of the crash itself but it relates to many of the things you have talked about in your testimony regarding all of the next generation related, aircraft weather related, data-link devices.

> The transcripts, released by the Federal Aviation Administration, show that controllers issued at least four warnings that sensors had detected wind shear, a rapid and potentially dangerous shift in wind speed and direction that many investigators believe may have played a role in the crash.
>
> The tower reported shear in all directions around the airport 6½ minutes before the accident. "We have, ah, low level wind shear alerts [in] all quadrants," the controller said. "Appears to be a frontal [storm] passing overhead right now. We're right in the middle of everything."
>
> Ten minutes before the crash, the pilot of a plane landing on Runway 10, which the Pan Am jet used, told the tower, "You got a 10-knot wind shear on one zero [Runway 10] at two hundred feet." That pilot's message was passed onto other planes in the area.

I guess my question is that New Orleans Airport had some of the low-level wind-shear detection and yet nothing seems to have happened with this information.

I guess what I am worried about is that you are proceeding in a lot of areas and hopefully there will be funding for you to develop these areas and yet if nobody uses the information it doesn't do any flying passenger any good.

And so, I would like you to comment on that. I mean, can we establish wind-shear minimums or maximums, to coin a phrase, that pilots ought to be aware of and ought to take advantage of?

Can we rely on the fact that you get timely information to pilots on weather information? I think a pilot can dial up information that may be as old as 3 or 4 hours. I guess what I am really saying to you is how do we transfer all of this technology that you are developing into preventing accidents from occurring?

Mr. FENELLO. Well, that is a very good question. I guess in answering it I should start with where we are today on, as Mr. Burnett referred to, the go, no-go decision. Today it is our responsibility, it is our job, to put in the hands of the pilot every scrap of information we can come up with. Hopefully, it will be as current as possible.

In the case you cited it couldn't have been more current.

The final decision in today's world rests with the pilot. He alone has the knowledge of all of the elements that go into the decision he would make.

The wind-shear information was one of them. The gross weight of his aircraft and, we could go down an entire list, his own capabilities are a factor. Whether he is a high- or a low-minimum captain, he carries the authority, not in just that one particular instance but in the entire conduct of his flight. He is the final authority on many go and no-go decisions he makes throughout that flight.

And I guess what we are saying is that as long as that is the prevailing modus operandi, if you will, your question will——

Mr. GLICKMAN. I don't want to totally cast all the blame on the pilot.

Mr. FENELLO. This is not an intention to cast blame on the pilot at all.

Mr. GLICKMAN. Because that same article talked about pilots saying that under certain circumstances shear alerts are not a prohibition on takeoff but one more piece of information to use.

Many pilots say they place important weight on reports from planes that have just passed through an area than on the sensors readings. Many pilots also say they do not get timely weather information from air traffic controllers or even from the weather stations that they dial up on their channel; that it is as much as 3 and 4 hours old.

And so I guess I am saying that there are a lot of factors involved here just because of the pilot's decision. But are you aware of any circumstance where a pilot delayed takeoff due to a windshear alert?

Mr. FENELLO. I have heard of them; yes, sir, I have heard of many pilots that have made the decision to no-go with a thunderstorm passing overhead.

Mr. GORE. Do you think that the wind-shear alert system is sophisticated enough to provide airport operators with sufficient reason to shut down an airport, let's say, temporarily due to wind shear?

Mr. FENELLO. I don't think that our information is that accurate.

Mr. GLICKMAN. So you would need more research on that particular point?

Mr. FENELLO. Yes, sir.

Mr. GLICKMAN. My second point is have you heard any commercial pilots delaying takeoff due to a wind-shear alert?

Mr. FENELLO. I can't answer to that. Walt, have you?

Mr. LUFFSEY. No, sir, I cannot think of a specific case. I am sure it must have occurred.

Mr. GLICKMAN. Would NASA have some of that information available in their reporting?

Mr. LUFFSEY. It is possible in the ASRS program they could have that. We could check on that and let you know for the record.

[The information follows:]

A review of ASRS data provided no additional information concerning pilots delaying takeoff due to a wind shear alert.

Mr. GLICKMAN. I guess the thrust of my question is fairly self-evident. We have all this sophisticated technology. If it doesn't get to the pilot it is worthless. If the pilot doesn't believe it is accurate or adequate it is not worth very much either.

I want to go to the next question of weather.

Mr. FENELLO. I guess it is apparent by our statement that we share that concern and we are putting an awful lot of effort into improving our capability to pass this weather information along and speed it up.

Mr. GLICKMAN. And timely information?

Mr. FENELLO. Yes, sir.

Mr. DUNN. Would the chairman yield?

Mr. GLICKMAN. Yes.

Mr. DUNN. I haven't read that item, but to have notification prior to takeoff that there are wind shears existing in an area is not an unusual circumstance. And if that article is referring to 10 knots, I don't think it would persuade any pilot to delay take off. That is not a big wind shear factor.

Do you have any statistics on how many times a day at some field that you have notification of wind shears existing? It has got to be fairly high?

Mr. LUFFSEY. Sir, I think you would find that it is fairly high.

Mr. DUNN. The point I am trying to make is that notification to a pilot that there are 10 knot wind shears in the area is not a valid reason to delay takeoff.

Mr. LUFFSEY. It is an alert.

Mr. GLICKMAN. But there are no standards that the FAA has issued at what level that wind shear speed might be, in fact, a danger to the pilot's takeoff?

Mr. LUFFSEY. Not in an absolute measure sense of what wind shear will do but in terms of the performance of the aircraft that is wellknown and documented.

Mr. GLICKMAN. I don't have much time. I just want to get to the next question of weather. It is of concern to me that the FAA as an institution, while you have some technological concern with weather, do not have what I call a good institutional relationship with the National Weather Service whereby you are in receipt of timely weather information.

Let me ask you this question. Why is there not a separate division of some kind within the FAA which is directed at weather?

Mr. FENELLO. Well, my colleagues here represent the specific areas of responsibility with regard to weather. You can say maybe the first area of responsibility would rest with Mr. Albrecht here in our research and development and our engineering group. He is responsible for developing the facilities that will be used in either collecting or disseminating the weather.

Even prior to him, of course, and inherent in the whole thing is responsibility of the U.S. Weather Bureau for obtaining the weather data and forwarding it to us. We use their products. We work together very closely in defining for them the kinds of products that would be useful to us, the forecasts and the timing and so forth.

Once we receive that information, the responsibility then passes to Ray Alvarez here in Air Traffic. They are the communication arm of the FAA and it is their responsibility to take that weather information and disseminate it to all who need to know, including the controllers, our operators, if necessary, to the pilots through the various systems we have set up for getting it to the pilot.

That is his specific responsibility. And, of course, in the course of that he establishes requirements, criteria, if you will, for seeing to it that his controllers understand what their responsibility is and what weather must be transmitted and so forth.

Walt Luffsey, who is head of aviation standards, you might call him the safety and flight operations arm, is responsible for establishing the requirements that the pilots will adhere to and fly to and he is working constantly with the aviation community in that regard.

We think that the area of responsibility is quite specific in the FAA. We don't have one head, if you warrant to call it one head. We do have a head in the sense that if at any time a particular concern is big enough to us that it wants a special task assignment, certainly the Administrator's office would step in and say, we are putting together the best heads we can find or even going outside of the agency to address a specific project.

Mr. GLICKMAN. I don't have any more time. I would just say that given the fact that nearly half of all the facilities are weather related, I would hope that your institutional framework would be able to manage this situation. It worries me that it may not be able to.

Mr. FENELLO. It is a legitimate concern and a good question and one we won't ignore. We will continue to review it.

Mr. GORE. Mr. Dunn?

Mr. DUNN. In the joint airport weather studies program that you referred to there, can you tell me who is doing the funding on that program?

Mr. ALBRECHT. Mr. Dunn, it is a joint program between FAA, the National Science Foundation, NASA, and NOAA.

Mr. DUNN. And you are participating?

Mr. ALBRECHT. Yes, sir. In fiscal 1982 we contributed a quarter of a million dollars. In fiscal year 1983 it will be $150,000 and in 1984 $32,000. That should fully fund the program.

Mr. DUNN. No further questions.

Mr. GORE. Mr. Shamansky.

Mr. SHAMANSKY. Thank you, Mr. Chairman.

Mr. Fenello, I fly out of Columbus to Washington at the beginning of the week and go back at the end of the week and I thought your choice of Columbus as an experimental site was a very wise choice. Somebody has a lot of good sense.

But what is worrying me is you have given us a dazzling display of all these things you are working on and what concerns me is that Mr. Burnett, Chairman of the National Transportation Safety Board, acknowledges that you begin a lot of things.

The question is when do you complete them? And I stress that because on page 10 of your testimony you say, "Next Generation Weather Radar," and then you say, "what we have now began in the fifties," and you project the next one will be ready in the 1990's and that is almost two generations in terms of people.

I had difficulty imagining what happened during that 40 years. Did you just suddenly come upon this stuff or what is it that took 40 years, the financing, the lack of technology that just wasn't there? That is a long time with the rapidity with which science moves in this area.

I am curious as to why the 40-year gap.

Mr. FENELLO. Well, you made a significant comment, Mr. Shamansky, when you said the rapidity with which science moves.

It is a fact of life that 1960 technology is practically obsolete now and for that reason we are embarked on, as you know, the upgrading of the entire system. Al, who has been here a long time, knows that and you may wish to comment, Al, on the progress that was made at intervals during that period.

Mr. ALBRECHT. I would like to address that issue, Mr. Shamansky, particularly the statement that the chairman made about the latest technology .

Let me give a few examples and weather radar, I think, is one of them. The current en route and terminal surveillance radars provide some levels of weather data. They were designed specifically not to see weather but to see aircraft so in that sense they are a very poor sensor.

We are upgrading those sensors with a program that will not wait. The new solid state radars will have a specific weather channel designed to detect weather alone. That will significantly upgrade our weather information.

Following that is the Nexrad program, the next generation radar, and that will be a Doppler radar that we believe will perform magnificently in terms of detecting weather, thunder storms, cold fronts, you name it, based on work done at the National Severe Storm Center.

It isn't as though we wait for the best things. We have a continuing program of putting improvements in the field as we go along.

The low level wind shear program I believe is another example of when we implemented something that we believe would provide a benefit, although it is not a perfect solution. We went out and did it.

The AWOS program, automatic weather observation system, isn't perfect. It doesn't do everything but it does a great deal. It puts a tremendous amount of new information into the system.

Mr. SHAMANSKY. In order to evaluate properly your efforts with these many things here and I don't think we have the tools to do that. By that I mean we have to go in and see when the idea originated, when you started to do something about it, how long it took to do that. We don't have the means to make that kind of evaluation.

So for you to testify on this it is helpful but it doesn't really tell the story. It is a dazzling display of topics. We don't have any good means, it seems to me, to really know how well you are doing. That will take someone with greater expertise and resources than this committee to handle.

But I think the question is there. It is the question whether the aviation community is going to have to find a manner of judging. You may come out very well on it. I don't know. Your mere recitation of this has a downside, too.

The other question I would like to ask you, getting back to page 7 where you refer to the experiment in Columbus, you say, "For general aviation aircraft." If I remember prior testimony in this committee, and the reaction of the Association of General Aviation Aircraft Owners, every time you come up with something that requires them to do something and there are a lot of them, they come and howl. They say you are imposing this cost on us. What do you intend to do with this system if it proves successful? Is it going to be a requirement? You have gotten the other requirements that you would like to impose for their safety. How are you going to handle it?

Mr. FENELLO. Well, as we have said in our recitation on the National Air Space System plan, if an operator wishes to take advan-

tage of all of the elements of the plan he will then avail himself of the equipment that enables him to participate.

If he chooses not to avail himself of all that is available, that is a decision he will make.

Mr. SHAMANSKY. It will strictly be voluntary as far as you are concerned?

Mr. FENELLO. Yes, sir.

Mr. SHAMANSKY. Can you name anything that you think should not be merely voluntary? Which item should be compulsory for general aviation in the reasonably near future?

Mr. FENELLO. I think at some point that Mode S, and TCAS might become requirements.

Mr. SHAMANSKY. Would you define those things? I am a layman.

Mr. FENELLO. TCAS is the collision avoidance device that was one of the first things that we announced as part of the revamping of the system.

This is a device that enables one aircraft to identify itself to another aircraft as being in the vicinity.

I am sure that the air carriers will move on implementing that very quickly. But I, too, have experienced the howls of anguish from general aviation pilots who said they are not sure they can afford equipage.

And, of course, the answer is if you can afford it, it would certainly be a great contribution to aviation safety.

If you can't initially, you just won't be able to avail yourself of certain services and there may be some parts of the air space that they will not be permitted to use as a result of that.

Mr. SHAMANSKY. There would be a penalty, then?

Mr. FENELLO. That is right, sir.

Mr. SHAMANSKY. Thank you, Mr. Chairman.

Mr. GORE. Mr. Walker?

Mr. WALKER. Thank you, Mr. Chairman.

I did have opening remarks that I was not able to be here for.

Mr. GORE. We already put them in.

Mr. WALKER. Thank you, Mr. Chairman.

I don't know who is the best one to answer the question but are there some aircraft, and I am talking here primarily about commercial aircraft, that are more weather sensitive than other aircraft?

Mr. LUFFSEY. You mean in a performance sense, sir?

Mr. WALKER. Yes; in other words, that are more prone to having problems if icing occurs. Are more prone to having problems in a wind shear situation.

Is this a known factor with which regulatory agencies have to deal in terms of individual aircraft?

Mr. LUFFSEY. Certainly the performance characteristics of an aircraft is taken through its full range and full operating envelope in the certification process to certify that aircraft.

In an operating sense all of the information within that envelope is given within the operations manual.

So the variability between aircraft may exist but to classify one as more prone than another would be hard for me to do at this point.

Mr. WALKER. Well, for example, and I am talking strictly from what I have heard on the news reports, there are indications that NTSB has said that Boeing failed to notify properly the airlines with regard to the nose down condition of their plane when it experienced icing.

Now, that would seem to indicate to me that Boeing had a responsibility with regard to that particular aircraft, I think the 737. Is that, in fact, the case?

Mr. LUFFSEY. Of course, the information you referred to, I think, was just mentioned yesterday publicly.

We have not had a chance to evaluate all the NTSB information. But as I understand the information, Boeing did provide a bulletin to their operators of Boeing 737 as did the FAA to its principal operations inspectors.

The evaluation of the process is what NTSB is doing.

Mr. WALKER. Back to the original question then. Is that saying that Boeing is saying in that particular directive that that particular aircraft is susceptible to some weather conditions?

Mr. LUFFSEY. I believe those types of operational bulletins are provided in fact to let the operators know the characteristics of the aircraft. In this case it would be for the Boeing 737.

Mr. WALKER. Would that also be true—can you name any aircraft that have susceptibility as shown by directives of that type that would have susceptibility to wind shear?

Mr. LUFFSEY. I can't name them, sir. I can check for the record.

Mr. WALKER. Well, do such directives exist, to your knowledge?

Mr. LUFFSEY. On wind shear specific sensitivities?

Mr. WALKER. On wind shear sensitivities, yes.

Mr. LUFFSEY. Not to my knowledge.

Mr. WALKER. Do they exist with regard to icing sensitivity?

Mr. LUFFSEY. I would think that there are icing characteristics that are reported.

Mr. WALKER. As I say, the NTSB criticism seems to be that the airlines and the people who have to fly these airplanes are not being sufficiently notified at the present time of those kinds of bulletins.

Are you confident that the appropriate information channels have been developed to assure flight crews that when faced with a decision in weather conditions that they know in detail the characteristics of the airplane and their performance in that kind of weather situation?

Mr. LUFFSEY. Yes, sir; I am fully confident that that is the case. We will evaluate any information from NTSB however.

Mr. WALKER. What is that mechanism?

Mr. LUFFSEY. From the airworthiness standpoint, if design changes are necessary we effect them through airworthiness directives. From an operating viewpoint, operating characteristics are provided through bulletins.

Mr. WALKER. This is a research and development hearing rather than some of the oversight hearings that we participate in over in Government Operations where I have seen much of you too.

What I am coming around to is, is there sufficient information being developed with regard to the plane's characteristics in various kinds of conditions?

You say you know of no specific information that has been developed with regard to wind shear .

Is that because all planes perform exactly the same in wind shear conditions or is it because we simply don't do very much evaluation of how they perform in wind shear characteristics and, therefore, haven't developed materials on it?

Mr. LUFFSEY. As regards certification we evalute the aircraft through its full envelope and then certify the aircraft if it meets the test.

As regards wind shear, there are operating training programs for crew dealing with wind shear for the specific airplane, some of which is done in simulators and some of which is done in ground school, and a pilot's own experience dictates knowledge of the variability in wind and wind conditions.

Mr. WALKER. Well, the question is, is information needed? In your opinion, you are the expert. You are the ones who have the role of regulating all of this, the oversight.

Do we need more experience about weather conditions as they affect particularly large commercial aircraft and is this something where there should be research dollars devoted toward weather conditions since the most recent crashes that we have on record certainly are directly related to weather conditions.

You know it seems to me that in speaking to a research committee what we want to find out is whether or not there is something here where our direction of priorities would result in safer flying for commercial passengers?

Mr. LUFFSEY. I understand your question, sir.

In a word the answer is yes. We need more and better information as reflected in our program outlined in the NAS plan. It is directed specifically at the items mentioned in the Deputy Administrator's statement .

Mr. WALKER. Thank you, Mr. Chairman.

Mr. GORE. Let me ask you, Mr. Fenello, about your statement that you are devoting a great deal of attention to weather problems and that it is a priority concern.

If weather as a factor in crashes is such a high priority, why did you recommend that the money for purchasing weather information from the National Weather Service be eliminated from your general fund budget this year?

Mr. FENELLO. We requested $26.7 million for NOAA in our 1983 appropriations to reimburse them for weather services they provide for us.

The House Appropriation Committee deleted it from the budget because there was no offsetting reimbursement provision for NOAA to pay FAA for the weather services FAA provides NOAA.

In light of the Appropriations Committee concern we are now studying the issue of what amount of service we do provide to NOAA. So I guess it was caught in the tangle of who was going to have the money and since it was pulled from the budget that is where we stand at the present time. We are studying it to see if we have to come back.

Mr. SHAMANSKY. Mr. Chairman, I don't understand the answer. I am sorry.

Mr. GORE. I am not sure I do, either, Mr. Fenello.

Mr. GLICKMAN. Is there a trust fund problem whether moneys come out of the trust fund or whether they come out of the general fund?

Mr. FENELLO. I don't know the answer to that.

Mr. GORE. Well, it is my understanding that traditionally the money has been budgeted out of the general fund and that as a budget savings, at least on paper, the FAA recommended that that not be done but that, instead, it be taken out of the trust fund which is designated for other purposes.

Now, is that correct?

Mr. FENELLO. I can't answer that.

Mr. GORE. Why not?

Mr. FENELLO. I am just not familiar with that.

Mr. GORE. If weather is such a top priority, and I don't want to be unfair but it seems to me that if the committee has to put the money back in the budget and if your budget request puts the money at risk, then that tells me that weather is not a very high priority down there in spite of the fact that it is a causative factor in over half of the fatal accidents.

Mr. FENELLO. The closest answer, I guess, is that I personally don't know.

Mr. GORE. Do any of your colleagues know?

Mr. ALBRECHT. Mr. Gore, I can't answer the question as far as the budget manipulations are concerned.

Mr. GORE. Well, you see, you have got nobody in charge of weather.

Mr. ALBRECHT. Well, sure we do.

Mr. GORE. Well, nobody at the FAA can even tell us where the money is supposed to come from for purchasing the weather data from the National Weather Service.

Now, if nobody is responsible for such a simple fact about weather related problems at FAA, then it is no wonder that no one is responsible for coordinating the effort to solve these weather related problems. You don't even know where the money is in the budget.

Mr. FENELLO. We owe you an answer and we will get you the answer. We will provide it for you.

[The information follows:]

U.S Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

August 18, 1982

The Honorable Dan R. Glickman
Chairman, Subcommittee on Transportation,
Aviation and Materials
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

It was apparent that there was a question regarding the funding of weather service activities left unanswered during my testimony before your Subcommittee on Wednesday, August 11. Consequently, I would like to take this opportunity to set the record straight regarding this subject - in advance of the full range of responses which are being prepared to be returned (as customary) with the Hearing transcript.

The Federal Aviation Administration's (FAA) budget requested $26.7 million of Trust Fund monies to pay the Department of Commerce (DOC) for aviation weather services, which would formerly have been paid out of Commerce appropriations in earlier years. Because such authorization is still awaiting final enactment, the House Appropriations Subcommittee on Transportation has reported deletion of this amount from the FAA FY 1983 budget. However, at the same time, we understand that the DOC budget would be increased by a like amount. Therefore, this action only deals with the source of financing for these services, and in no way involves a program reduction. Whether or not the FAA appeals it, the Subcommittee's action involves no reduction to the DOC's FY 1983 funding for aviation weather services.

We hope this information will clarify any misunderstanding on this subject.

Sincerely,

Michael J. Fenello
Deputy Administrator

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C. 20515

August 19, 1982

Honorable Michael J. Fenello
Deputy Administrator
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Dear Mike:

Thanks for your recent letter regarding the source of the funding for the Federal Aviation Administration's aviation weather services. I appreciate your thoughtfulness.

As you know, the House and Senate conferees on the Airport and Airway Improvement Act agreed to the OMB request to fund aviation weather services through the Airport and Airway Trust Fund and authorized $26.7 million for fiscal year 1983. As the legislative process continues, I intend to follow this matter closely.

On a related issue, it is not yet clear to me where the $5.5 million to pay the CWSU meteorologists appears in the budget. There is, in fact, no identified budgetary line item to cover this expense. This, in itself, helps to contribute to the kind of confusion that arose in our hearing last week.

The Subcommittee on Transportation, Aviation and Materials supports the intent of the FAA to upgrade aviation weather programs as a key element of the National Airspace System plan. I stand ready to assist you in the implementation of this important program.

With best regards,

Dan Glickman, Chairman
Subcommittee on Transportation,
Aviation and Materials

DG:cs

US Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

SEP 13 [illegible]

The Honorable Dan R. Glickman
Chairman, Subcommittee on Transportation,
Aviation and Materials
Committee on Science and Technology
House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

Thank you for the opportunity of clarifying information regarding the funding of weather service activities.

In your recent letter, you have a question regarding where in our budget the funds for the Center Weather Service Unit (CWSU) meteorologists are shown. These funds are in the Operations appropriation, Air Traffic Activity, Center Subactivity. It is true that this item is not a separate line item.

We hope this information answers your question.

Sincerely,

Michael J. Fenello
Deputy Administrator

Mr. GORE. Well, OK. We will hold the record open for that answer. But isn't my point a fair one? If you don't have anybody in your organization who even knows where the money is in the budget for purchasing the basic information from the National Weather Service, isn't that a clear indication that your organizational structure is faulty and that you ought to have somebody who is in charge of weather problems?

They account for 50 percent of the fatal accidents. Shouldn't you have somebody in charge of them?

Mr. ALBRECHT. Mr. Gore, it is not a true statement that no one in the organization knows where the money comes from. The budget department certainly does. We just can't answer that specific detailed question at this time.

Mr. GLICKMAN. Would the chairman yield to me?

Mr. GORE. Yes, I will yield to Chairman Glickman.

Mr. GLICKMAN. Is it probably not the problem that the Office of Management and Budget is engaged in financial manipulations of this budget to make it look like the general fund is more in balance than it is and for that reason they are pushing numbers around with the trust fund and in the end what happens is that the amount of money going for weather services is decreased by $25 million just because Mr. Stockman thinks it will make the budget look a lot better?

Is that probably not what the real problem is here?

Mr. GORE. I would say that is a pretty fair guess. I will be glad to yield to Mr. Shamansky.

Mr. SHAMANSKY. Well, this dancing around, I was forced to comment I didn't understand your answer. First, I said maybe that was something wrong with me. I decided no, it wasn't wrong with me. I didn't understand your answer and apparently you haven't come up with a very good answer so far.

The problem, it seems to me, is that you do have to respond to these budget cuts and you are doing the best you can and it isn't very good.

I am not necessarily picking on you but when we present these questions to you directly I think it doesn't enhance, frankly, your credibility with us for having a distinguished panel like this say, gee, it is the other guy's responsibility. We don't happen to know.

Something as crucial as this you have got to do better than that because we are here to help you, not to hinder you.

Mr. FENELLO. We will provide the answer for you.

Mr. SHAMANSKY. Thank you.

Mr. GORE. All right.

Let me make what I hope is a constructive suggestion. We found in a whole series of hearings that a lot of these problems in Government agencies relate to information management. I am sure you find similar problems all the time. But when you have got a single causative factor, a single set of factors, weather, that account for over half of the problems that you are trying to eliminate, you have just got to organize your effort in a way that focuses on that major causative factor, it seems to me.

Now, the testimony you give is impressive on the surface but it is indicative, it seems to me, of an organization that has a lot of different activities going on that aren't really coordinated and

pulled together in a way that gets the correct up-to-the-minute information to the person who needs it at the time.

So I hope that out of our recommendations and the hearings that we can address that problem better.

I would like to turn briefly, if I might, to an incident that I will refer to in my opening statement.

Congressman Tom Downey of New York brought this to the attention of the subcommittees and I would like to ask you about it. And without objection, I would like to put information from the FAA and the National Transportation Safety Board from the FAA into the record on this and this is a report that you all provided on this.

A brief summary of this incident is as follows:

On Monday, July 12, a private airplane designated 37 Lima, took off from the Suffolk County Airport on Long Island after receiving proper clearances.

There was a low ceiling of fog. It contacted one of the Islip East controllers and was asked to stand by. The pilot was standing by, but contact was never reestablished. An hour later the controller was asked about 37 Lima as flight strip and evidently the controller assumed that the plane had proceeded on its flight plan and had landed. In fact, there is good reason to believe that it crashed but instead of conducting a search, nothing was done for 2½ days until someone who knew the pilot came to the FAA asking for information about this plane.

Is it your current assumption that this plane went down in the ocean or somewhere else and was never heard from again and no search was started for 2½ days?

Mr. FENELLO. It is regrettable that the search wasn't started for 2½ days and there is no question but that the flight strip was misplaced.

The controller did not get back to the airplane and neither did the pilot initiate any call back to us. As soon as the loss was called to our attention we proceeded to work with the search and rescue effort and are continuing to do so.

The action, as far as the controller is concerned, we have provided all of the information we had. We actually had the flight strip put aside where it normally would go after it was found and I guess that investigation continues. The action against the controller is still pending.

Mr. GORE. Is it fair to characterize this as a major error?

Mr. FENELLO. With a possible loss of life, yes.

Mr. GORE. Is it fair to ask whether or not the continued working of these people 6 days a week with overtime might have been a contributing factor in losing the plane?

Mr. FENELLO. We have no indication that that had anything to do with it.

Mr. GORE. Well, let me ask you this. Is it correct to say that the mistake of the controller probably did not contribute in any way to the crash?

Mr. FENELLO. That is correct.

Mr. GORE. And the error was in not making possible an immediate search and rescue operation which might have conceivably

saved a person's life. No one knows the circumstances. We haven't yet confirmed if it was, in fact, a crash, correct?

Mr. FENELLO. That is correct.

Mr. GORE. Nobody knows where the plane is, but the friends and relatives of the pilot just haven't been able to find any indication that it was anything but a crash.

Well, what is going to be done about that?

Mr. FENELLO. I don't know what the final outcome will be. I imagine the search effort will continue to see if we can pick up some clues as to what might have happened to that airplane.

As you know, this happens across the country, not with regularity but occasionally an airplane is missing and sometimes it is months before they find traces of it or the wreckage.

Mr. GORE. It is extremely uncommon for a plane to fall off the radar scope and for it to just be lost from the air traffic control system and no search to be started, isn't it?

Mr. FENELLO. It is my understanding he was never identified as being on the radar scope.

Mr. GORE. He was within the jurisdiction of the air traffic controllers and they were supposed to be keeping track of him by radio contact; is that correct?

Mr. FENELLO. That is correct, sir.

Mr. GORE. Well, I will put additional material in the record on this incident. Without objection, we will hold the record open for any additional comments that you wish to supply related to this incident.

[The information follows:]

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

SEP 20 1982

The Honorable Dan R. Glickman
Chairman, Subcommittee on Transportation,
Aviation and Materials
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

Enclosed is a copy of the corrected transcript of FAA's testimony before the joint Science and Technology Subcommittees on August 11, along with submissions for the record. At the hearing, questions arose regarding the incident in which 2 1/2 days passed before a search was initiated for a plane which had taken off from Suffolk County Airport and was not heard from again. In addition to FAA's efforts, the NTSB has undertaken an investigation of the incident. Also, appropriate disciplinary action has been initiated by the FAA in this matter.

I have also enclosed, for the record, a copy of Deputy Administrator Fenello's letter discussing the funding of the weather services provided to FAA by NOAA.

Thank you for the opportunity to correct the transcript and clarify these matters for the record.

Sincerely,

J. E. Murdock III
Chief Counsel

Enclosures

Mr. GORE. Why don't we have a second round.

Chairman Glickman.

Mr. GLICKMAN. Let me just ask a couple of questions.

Mr. Alvarez, our tower personnel, the people who bring the airplanes in, are they recipients of on-time weather information provided by the National Weather Service?

If I am landing at Wichita or Kansas City or Chicago, are those tower personnel who are looking at radar screens, as Mr. Albrecht says, designed to see airplanes and not thunderstorm cells. Do they have on-time weather information available to them?

Mr. ALVAREZ. Yes, sir. The tower controllers have the current weather observations for their local area. Almost as soon as the meteorologist or the weatherman produces the weather it is transmitted directly to the tower.

Additionally, the terminal radar does indicate to the controller, if he has radar in that facility, the precipitation and the contour of the weather in the area.

As Mr. Albrecht has mentioned, the radar has been fine-tuned to eliminate a lot of the clutter but most of the large cells will still appear on the radar terminal facility scope. The controller gets weather information directly from the meteorologist and also any advisories of severe weather from the center weather service unit if it is appropriate to his position.

Mr. GLICKMAN. No, the big problem with the Southern Airways crash in Atlanta is that the airplane was vectored directly into the thunderstorm cell and you are telling me that can't happen because en route personnel are so familiar and can see in such minute detail existing weather systems that that would not happen again?

Mr. ALVAREZ. I think you are mixing up two different kinds of control environments, Mr. Glickman.

The accident that happened in the Georgia area in 1977 happened well before the center weather service unit was implemented as well as a lot of other dissemination procedures.

In a terminal the controller has direct access to weather in the area because it is happening right there and he gets it directly from the meteorologist.

In the en route environment it may be an hour or longer before the center controller gets the signet information in some extreme cases from the system, so we may be lagging behind as far as this type of information is concerned.

Mr. GLICKMAN. Personally, recently I flew back from New York on a shuttle and we were landing in Washington. There was a line of severe thunderstorms in Washington and they vectored us to Richmond and back and pretty soon we found ourselves right in the middle of very severe weather and I just want to be assured that as far as you are aware your controllers are not so busy vectoring aircraft that they cannot look at weather and have immediate weather information available to them so that they are not vectoring aircraft into severe weather.

Mr. ALVAREZ. If the controller has the information available to him the chances of him vectoring traffic into weather is very, very remote.

Mr. GLICKMAN. What if he doesn't have that information?

Mr. ALVAREZ. If he doesn't have the information then the vectoring is based on the air traffic control situation, not on weather and it could happen.

Mr. GLICKMAN. So as Mr. Gore talked about, then the real problem is to insure that we have an information link. That is a lot of the things that Mr. Fenello mentioned in his testimony in terms of the next generation of items. I guess my concern is that we give you enough funds and the administration provides you enough support so that you are able to implement those kinds of things, that your controllers are on top of it so that they get the information, and pilots use it.

And I guess what worries me is that there are so many pieces of this pie that occur during very busy times and very bad weather and at very busy airports, that the problems may not be as acutely recognized as they should be.

Mr. GORE. A lot of times during these periods when new scientific instruments are coming out and electronics are getting fancier and fancier, there is a tendency to always look for a hardware solution to a problem.

Information management sometimes can be improved dramatically just by making available the information that you already have to the right people.

I am not persuaded that that is not the real problem here. If you wait on the simultaneous display technology—and when is that coming out? That could be quite some time, couldn't it?

Mr. ALBRECHT. Again, Mr. Chairman, it will probably be the mid to late eighties before you have total information as precisely as we know how to make it with current technology displayed on a console in a center.

The Nexrad will probably provide the basic sensor information.

On the other hand, as products become available, and I think AWOS is an example of a program we intend to implement very soon, we make those products available to the centers, to the tower, and to the flight service station.

So it is not a matter of waiting for the elements. It is a matter of getting that data which is available as soon as we can.

Mr. GLICKMAN. I would have to say one thing that is positive. You have an Administrator who I think is dedicated not only to modernizing the system but trying to engage in some of the things Mr. Gore talks about such as better management of an agency that has had serious management problems over the last several years. And I am just hopeful that you can get the support from Congress and that the administration doesn't try to squeeze you over the next several years so that you don't have enough research and development funds or facilities to implement some of the things that we talked about today.

Mr. GORE. Mr. Shamansky.

Mr. SHAMANSKY. Thank you, Mr. Chairman.

Mr. Fenello, you will provide us with the information you said regarding the funds for weather services?

Mr. FENELLO. Yes, we will.

Mr. SHAMANSKY. I would like you, if you can, to provide us with another list and that would be a list of projects that the FAA

hasn't yet started, how you rate them in order of importance and the reasons why they haven't been started.

I think obviously that is in the future but it would tell us a lot, it seems to me, about what you are handling, what you can't handle and why.

So we want to be supportive but if we don't know what else is waiting in the wings it is hard for us to assist you.

[The information follows:]

The Federal Aviation Administration is presently involved with ongoing projects in all current weather-related research activities within the state-of-the-art. As such, they are identified in the NAS Plan. We also have continuing efforts to investigate new techniques, sensors and devices which could possibly be applied to aviation weather requirements.

We are unaware of any aviation weather related effort that has been deferred and is not currently being addressed in our programs.

Mr. FENELLO. I think we have spelled out quite a bit of that in our plan but we will give you a specific list.

Mr. SHAMANSKY. Thank you.

Mr. GORE. Mr. Dunn?

Mr. DUNN. Does anybody know how many employees the FAA has?

Mr. FENELLO. The exact number, about 40,000 to 45,000. The number has been coming down steadly in the last 2 years.

Mr. DUNN. I assume some of those are accountants.

Mr. FENELLO. Yes, sir.

Mr. DUNN. Would you agree that it was an oversimplification for the chairman, Mr. Gore, to say that because out of 45,000 FAA employees, 4 of them here couldn't answer the question on funding and, therefore, the FAA hasn't got its act together?

Mr. GORE. Will the gentleman yield?

I know a leading question when I hear one.

Mr. DUNN. I will yield in a moment. You said we can't get the answer and, therefore, the FAA hasn't got its act together. There are 45,000 people in FAA and 4 of them are here. I am not surprised that four of them can't answer all the questions for the FAA.

Mr. GORE. I appreciate the gentleman yielding.

We called this hearing specifically to inquire into the actions of the FAA concerning weather as a causative factor in serious accidents.

Now, one of the issues is how high a priority is FAA placing on weather as a causative factor. It is responsible for 50 percent of the accidents, after all. And we asked Mr. Fenello to come with the people who were chiefly responsible for handling and managing problems related to weather.

These 4 people are not just 4 people picked at random from among the 45,000 employees at FAA. These are the people who are supposed to be in charge of managing weather-related problems and the information related to weather at FAA.

If the four people who are in charge supposedly of weather don't have basic information like that, then I think it is very revealing about the organizational structures that now exist.

I am sure that there are some accountants at FAA who can provide and will provide for the record the answer to the question that

we ask. But I am surprised and I do think it is significant that the people in charge don't have it.

Mr. DUNN. I guess we still disagree. You are right, they are in charge of the programs. For example, Mr. Albrecht is an expert on research and development, but that doesn't necessarily make him an expert on the funding for this program. I don't think that is his responsibility.

Mr. GORE. I guess he knows a little bit about how much money there is for R&D and where it is in the budget.

Mr. DUNN. I am just trying to make the point that we have made some very simple statements about a very complex problem, weather.

Mr. Shamansky talked about improvements in 40 years. As a pilot who has known the system for the last 20 years, I have seen a tremendous amount of improvement.

There are problems in FAA. When you talk about weather, I am not sure the committee has a full understanding of just how complex the problem is.

A week ago Monday night I came into National a little after 10 o'clock at night in the middle of a thunderstorm. The controllers were working at least 20 aircraft in the area. They did a super job of routing me around a severe weather center over Dulles Airport, so I appreciate the job that FAA is doing. I say they have made tremendous progress, and we shouldn't make oversimplified statements.

I understand how complex the problems are, and I applaud the FAA.

Mr. FENELLO. Thank you, sir.

Mr. GORE. Let me say for the record that the Science and Technology Committee has to really walk the straight and narrow on aviation issues because Mr. Dunn has extensive experience as a pilot and lets us know when we make any mistakes.

That last incident wasn't such an occasion, however.

Mr. DUNN. If I may have the final word, I am not calling it a mistake. I just had a very grave concern that we were oversimplifying a complex matter.

Mr. GORE. Let me ask you, just briefly, Mr. Fenello, or Mr. Albrecht, how far away is onboard Doppler weather radar that can give the pilot real-time, low-level convective hazard warning of the kind useful for takeoff and landing?

Is that in the foreseeable future?

Mr. ALBRECHT. Concerning air-derived, onboard Doppler radar, Mr. Chairman, we have just finished some tests with airborne equipment. Those tests are under evaluation. We expect we will have the results this fall or early winter.

At the risk of starting another conversation, I can't give you a specific date because I don't know what the results are. I would submit that airborne radar is probably not the best way to get Doppler information over the distances that are of interest to you. It takes a lot of power and a lot of sophisticated processing which very likely will have to be done with a much larger ground system and then piped to the cockpit over mode S.

Mr. GORE. Thank you.

Mr. Albrecht, you remember our previous proceedings which dealt extensively with the deicing procedures as a result of the Air Florida Flight 90 tragedy. Has the FAA made any progress in recommending procedures for deicing as well as what the appropriate glycol water solution ought to be?

Mr. ALBRECHT. I think perhaps Mr. Luffsey ought to follow this with an answer on where we stand. On the other hand, we made a commitment to the committee and we said that we had initiated a study program on glycol before the Air Florida crash. That study has progressed.

We expect preliminary results in October and the final results will be available, as promised, in December. We made some 117 different measurements on that subject so we are working on the problem.

Mr. GORE. Mr. Luffsey, do you want to comment?

Mr. LUFFSEY. I would just add to it, sir, in terms of any form of implementation, of course, that it would await the results of the R&D program.

As regards the regulatory requirement today, the clean wing concept still prevails, and it is the most appropriate.

Mr. GLICKMAN. May I just ask a question along that line?

Do you envision at some point coming out with regulatory standards of the proper mix of glycol water solution?

Mr. LUFFSEY. Again, sir, that would be the result of the program—specifically what it might call for and whether or not the regulatory program is the best way to get it implemented quickly.

It could be that the advisory circular route could be the best way to get it done.

Mr. GLICKMAN. Do we have advisory circulars available on this issue in the last 30 years?

Mr. LUFFSEY. We have included in the operators program their approach to deicing.

Mr. GLICKMAN. I guess that is my question that all we have is advisory circulars on deicing. Perhaps the NTSB's report today will indicate some clarity on this issue but I would urge you not to back away from issuing a regulation if you think that it is necessary.

Mr. LUFFSEY. I appreciate that, sir. Certainly we will.

Mr. GORE. Has the FAA made any progress in conjunction with NASA or on its own in evaluating runway friction and correlating that?

Mr. LUFFSEY. Specifically, on correlation, we have asked that NASA conduct a correlation analysis and provide the results to us. That correlation analysis would be measurements taken from a friction measurement device, whichever type, to the performance of specific aircraft in tabular form.

Mr. GORE. When do you expect that?

Mr. LUFFSEY. We don't have a firm date on that yet from NASA. NASA is completing the program.

Mr. GORE. Fine.

For purposes of the record let me note that the two gentlemen missing in the apparent crash that I referred to earlier are Mr. Steven Wise of East Providence, R.I. and Mr. Raymond Mooney.

Gentlemen, you may wish to stick around and respond. We will give you an opportunity to if you would like to hear our next wit-

nesses but at this point we will excuse you with the thanks of the subcommittee.

Mr. GORE. Our next witness is Mr. Jack Howell, executive central air safety chairman, Air Line Pilots Association.

Mr. Howell, I want to welcome you to these two subcommittees.

Would you identify yourselves for the reporter, starting from my left?

STATEMENT OF JACK HOWELL, CHAIRMAN, EXECUTIVE CENTRAL AIR SAFETY, AIR LINE PILOTS ASSOCIATION, ACCOMPANIED BY PATRICK W. CLYNE, CAPTAIN, NORTHWEST AIRLINES, INC.; WILLIAM W. MELVIN, CHAIRMAN, AIRWORTHINESS AND PERFORMANCE COMMITTEE; JOHN E. O'BRIEN, DIRECTOR, ENGINEERING AND AIR SAFETY, ALPA; AND ART HANSEN, PRESIDENT, HYDRO/MET LTD.

Mr. HOWELL. Capt. Bill Melvin, who is chairman of our airworthiness performance committee; John O'Brien, director of engineering and air safety, and Pat Clyne, who is a local air safety chairman for Northwest Airlines in the Minneapolis area.

Mr. GORE. Very good, we welcome all of you.

Without objection, your entire text will be included in the record in full. At this point if you wish to summarize we invite you to do so.

I understand that you have in your presentation some video material that will demonstrate something about the onboard Doppler; is that correct?

Mr. HOWELL. Yes, sir, we are prepared to introduce an additional guest and at that time it would be appropriate for us to do that.

Mr. GORE. You go ahead and proceed.

Mr. HOWELL. Thank you.

We appreciate the opportunity to appear before you today to present the views of ALPA in regard to the needs and opportunities for improvement in the distribution of weather information to pilots.

Since the tragic wind-shear accident at Kennedy Airport in June 1975, ALPA representatives have appeared before many congressional committees which were examining the relationship of weather and aviation safety.

In our testimony we have stated repeatedly that additional improvements are needed in the forecasting and dissemination of aviation weather information.

We have also identified two particular concerns with respect to weather conditions in the terminal area. That is, one, the systems installed at airports today to detect severe weather phenomena are grossly inadequate; and two, the means intended to pass this meager information to the flight crew in a rapid manner are ineffective.

Today we echo these concerns and we will give you some further examples of the quality of weather information, or the lack thereof, with which airline pilots must contend.

I would also like to tell you what we think are our pressing requirements, to share with you our concerns about some future

weather programs, and, finally, to describe the void in leadership which we see in aviation weather programs.

The accuracy and currency of weather information provided to the pilot deserves some attention. For example, the National Weather Service provides aviation forecasts for a period covering 18 hours, supplemented with a 6-hour outlook. Because of the extended timeframe this forecast covers, many broad generalizations are made which tend to degrade the quality of the forecast.

We believe a forecast for a period covering a shorter timeframe would allow the meteorologist to be more specific and accurate in his predictions.

However, unless the National Weather Service is provided the resources it needs to accomplish this task, we doubt if any improvement in this area will be forthcoming in the near future.

En route wind information provided to the pilot is also frequently in error due to untimeliness. Again, economic considerations appear to be a major reason for this. Several years ago the National Weather Service was forced to reduce its upper air soundings to one every 12-hour period.

Thus, by the time the data is collected and disseminated, it is not unusual for a pilot to be given wind forecasts based on raw data which is 15 hours old. Certainly we can do better than this.

And, indeed, investigations have been undertaken which examined the feasibility of using INS equipped aircraft as a source of data for high altitude wind conditions. This work should be continued since initial results have proven promising.

The National Weather Service produces a radar summary chart on an hourly basis which is to be used by pilots for flight planning purposes.

The system utilizes storm detection radar reports to prepare a map of the domestic United States outlining all significant thunderstorms that exist at that time. The system is grossly inadequate.

In the first example [fig. 1], you will please note that the majority of the country is covered with the letters "NA"—for not available.

The areas outlined in green are identified by the NWS as containing weather; the areas in red actually contained weather as evidenced by the NWS storm detection reports, but that information never appeared on the summary.

This chart is for August 6 at 7:30 a.m. It is not unique. It is representative of the weather information that is or is not available to this Nation's pilots.

The second example [fig. 2] is truly extraordinary. On July 29 the NWS transmitted this map. As evidenced by the plethora of NA's that extend the length and breadth of the chart, no information was available from anywhere in this country. But using the NWS's own storm detection reports, we have drawn in three very large areas of significant weather.

The problem is not that the NWS is unaware of the weather, but that the Service is unable to get their information onto their radar summary chart.

[Figs. 1-3 follow:]

P TIME 1157Z START 1158Z
LOCAL WARNING RADARS--NONE
JT/LVL5
JT/LVL4
JT/LVL4
GEND...
ECHO AREAS
TOPS AT INTENSITIES 1-3-5
--BASES 999--TOPS OF FT
--AREAS+LINES--PENNANTS
--CELLS--ARROWS WITH SPEED
CIP TYPE AND CHANGE OF INTENSITY
NEW OR INCRG. - DCRG
WEATHER WATCH AREAS
FRIDAY
1135Z AUG 06. 1982 RADAR SUMMARY
D128

FIGURE 1

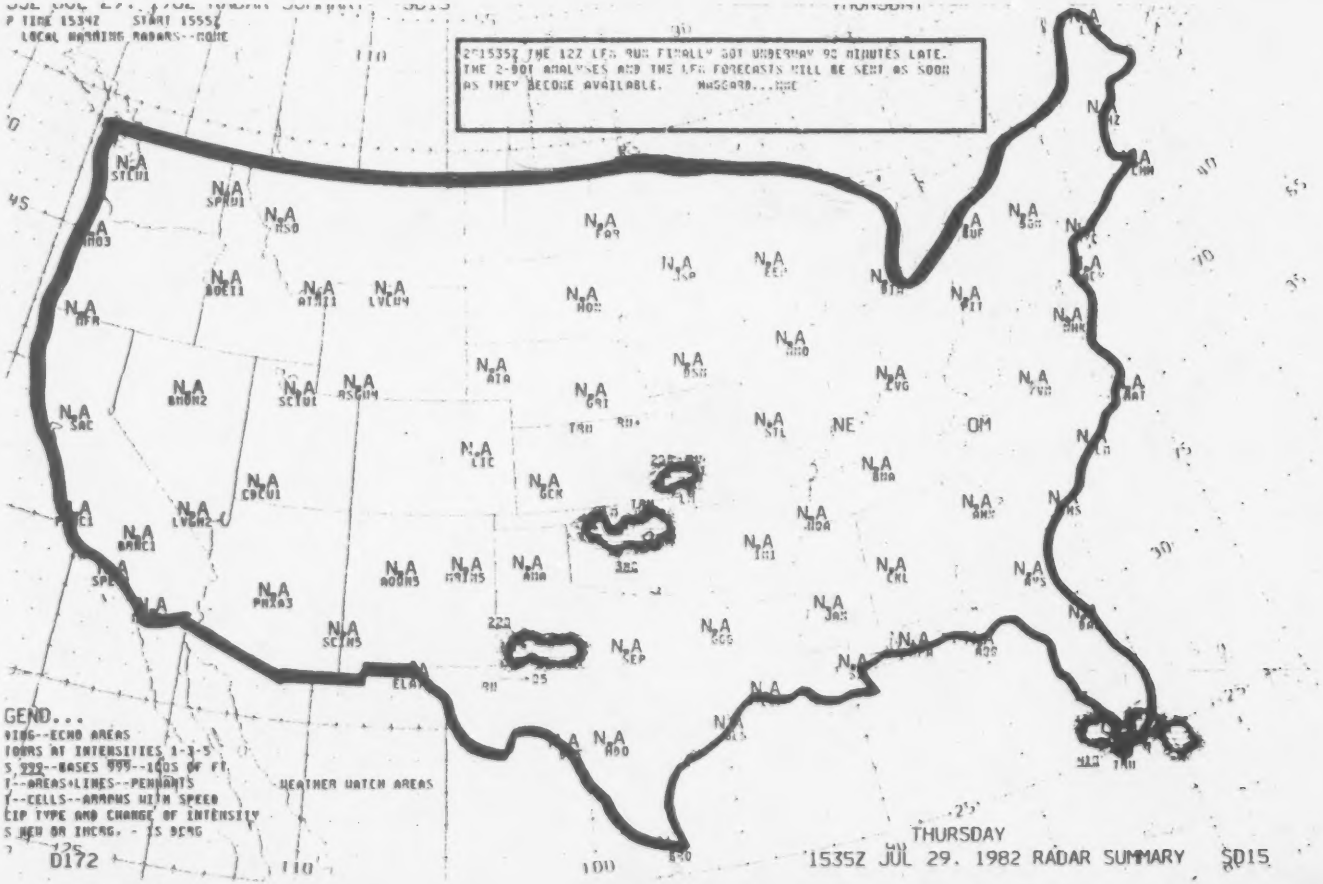
P TIME 1534Z START 1555Z
LOCAL WARNING RADARS--NONE
2?1535Z THE 12Z LFM RUN FINALLY GOT UNDERWAY 90 MINUTES LATE.
THE 2-901 ANALYSES AND THE LFM FORECASTS WILL BE SENT AS SOON
AS THEY BECOME AVAILABLE. NMSCRD...NHC
GEND...
RIDS--ECHO AREAS
TORS AT INTENSITIES 1-3-5
S 999--BASES 999--100S OF FT
T--AREAS+LINES--PENNANTS
T--CELLS--ARROWS WITH SPEED
CIP TYPE AND CHANGE OF INTENSITY
S NEW OR INCRS. - IS DERG
WEATHER WATCH AREAS
D172
THURSDAY
1535Z JUL 29, 1982 RADAR SUMMARY SD15

FIGURE 2

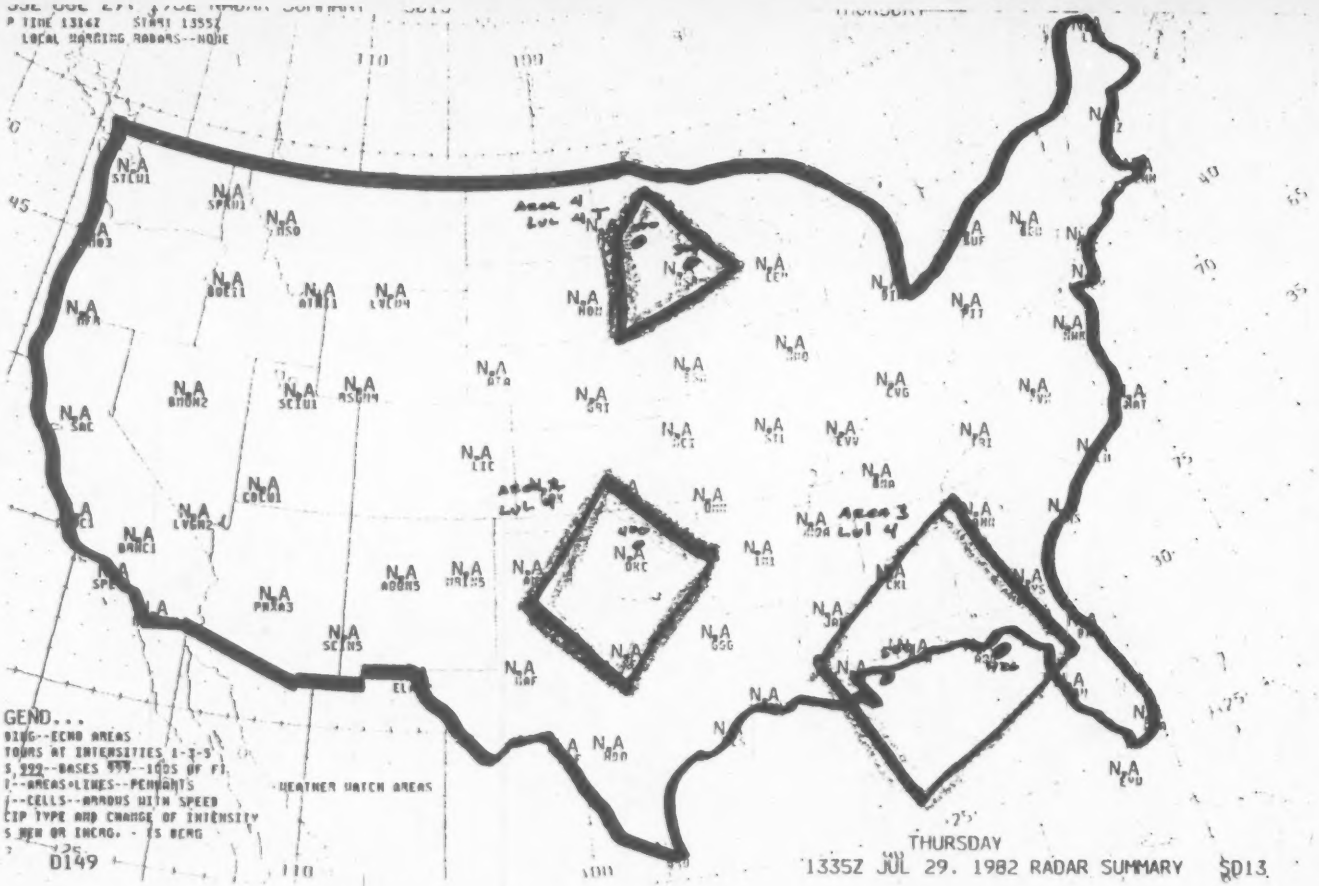
P TIME 1314Z STNS 1355Z
LOCAL HANGING RADARS--NONE
GEND...
BIRD--ECHO AREAS
TOWERS AT INTENSITIES 1-2-3
S 222--BASES 999--TOPS OF FI
!--AREAS-LINES--PENNANTS
/--CELLS--ARROWS WITH SPEED
CIP TYPE AND CHANGE OF INTENSITY
S NEW OR INCRG. - DS DCRG
WEATHER WATCH AREAS
D149
THURSDAY
1335Z JUL 29. 1982 RADAR SUMMARY SD13

FIGURE 3

Mr. HOWELL. While en route to a destination, the primary access a pilot has to real time weather information is through his airborne weather radar. Yet, the requirement for airlines to equip their aircraft with weather radar is somewhat tempered by an exemption for airplanes used solely within the States of Hawaii and Alaska.

Our experience and other weather data indicate that thunderstorms and heavy precipitation are not all that uncommon in both of these locations. We are of the opinion that all FAR part 121 operations should be required to carry weather radar.

The FAA has in the past made attempts to enhance the ability of pilots to obtain real time en route weather information. But in all reality they have had little success. For example, following the Southern Airways accident some years ago in Georgia, the FAA implemented a center weather service unit [CWSU] program for each of its air route traffic control centers.

While these facilities are staffed with professional meteorologists, their efforts are directed toward insuring that air traffic controllers in the centers and other ATC facilities within the centers' jurisdictions are informed about severe weather possibilities rather than providing this critical information directly to the pilots.

Apparently the idea is that the pilots will benefit in the long run, but such is not always the case. The lack of standardization within these facilities and ineffective communications between the CWSU and other weather/aviation oriented facilities are direct causes of system deficiencies. Whether the communications problem is procedural, or due to inadequate land lines, the result is the same.

Likewise, if the CWSU, the FAA Central Flow Control Facility in Washington, D.C. and facility controllers do not talk to each other, the result is equally bad.

Another so-called en route weather aid is the "En Route Flight Advisory Service," referred to as EFAS. These facilities share one common frequency, and while they may provide a valuable service to general aviation aircraft flying at slower speeds and lower altitudes, they are of little value to air carriers.

The FAA has tested a high altitude version of this service in the Western United States and airline pilots who have used it commented very favorably on the service they have received.

We understand that preliminary discussions relating to the frequency management problems associated with the high altitude EFAS program are now in progress. Our fear is that if they progress at the same rate other frequency management problems have, only our grandchildren may see the fruition of this program.

As stated earlier, Mr. Chairman, we have particular concern over the inability to get accurate information on severe weather conditions in close proximity to the airport.

What is lacking is precise information on wind shear associated with downbursts, gust fronts, or low level jet streams, and heavy precipitation.

Because these phenomena are so localized and dynamic in nature, we need sensors that can acquire accurate data and then provide this information on a timely basis to flight crews.

There are no systems installed at any airport today which can provide this service, but we are encouraged by current research of a Doppler radar technique that might prove to be an adequate sensor.

We understand, Mr. Chairman, that you have a witness to follow us who will present more detailed information on one Doppler radar technique.

Mr. Chairman, these are but a few of the deficiencies that exist in today's aviation weather services provided to airline pilots.

Little has been done to provide the pilot in the cockpit with real time specific, short-term decisionmaking information. This situation must be corrected. While we certainly agree that air traffic control facilities also need similar data, it is only in the cockpit that all elements of the decisionmaking process can and must be available. Therefore, all near-term efforts in the area of aviation weather service should be directed toward this end.

Now I would like to have Captain Clyne comment briefly on two new weather-related systems the National Weather Service and the FAA are exploring. They are the implementation of an all-digital radar code planned for November 1982 and the Nexad radar.

[The prepared statement of Mr. Howell follows:]

STATEMENT OF
JACK HOWELL
EXECUTIVE CENTRAL AIR SAFETY CHAIRMAN
AIR LINE PILOTS ASSOCIATION
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U. S. HOUSE OF REPRESENTATIVES
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WEATHER INFORMATION

Mr. Chairmen and members of both Subcommittees, I am Jack Howell, Executive Central Air Safety Chairman of the Air Line Pilots Association which represents the professional interests of over 33,000 pilots who fly for 38 airlines. With me today are Captain William W. Melvin, Chairman of ALPA's Airworthiness & Performance Committee; Captain Patrick Clyne, ALPA Local Air Safety Chairman for Northwest Airlines, and John O'Brien, Director of ALPA's Engineering & Air Safety Deprtment. We appreciate this opportunity to appear before you today to present the views of ALPA in regard to the needs and opportunities for improvement in the distribution of weather information to pilots.

Since the tragic wind shear accident at Kennedy Airport in June of 1975, ALPA representatives have appeared before many Congressional committees which were examining the relationship of weather to aviation safety. In our testimony we stated repeatedly that additional improvements are needed in the forecasting and dissemination of aviation weather information. We also identified two particular concerns, with respect to weather conditions in the terminal area. First, there are no systems installed at airports today which will accurately detect severe weather phenomea and second, there is no means to pass this information to the flight crew in a rapid manner.

I would like to give you some examples of the quality of weather information, and in some cases the lack thereof, with which airline pilots must contend. I would also like to tell you what we think are our pressing requirements, to share with you our concerns about some future weather programs, and to describe the void in leadership which exists in aviation weather programs.

The accuracy and currency of weather information provided to the pilot deserves some attention. For example, the National Weather Service provides aviation forecasts for a period covering eighteen hours, supplemented with a six-hour outlook. Because of the extended time frame this forecast covers, many broad generalizations are made which tend to degrade the quality of the forecast. We firmly believe a forecast for a period covering a shorter time frame would allow the meteorologist to be more specific and accurate in his predictions. However, unless the National Weather Service is provided the resources it needs to accomplish this task, we doubt if any improvement in this area will be forthcoming in the near future.

En route wind information provided to the pilot is also frequently in error. Again, economic considerations appear to be a major reason for this. Several years ago the National Weather Service was forced to reduce its upper air soundings to one every twelve-hour period. Thus, by the time the data is collected and disseminated, it is not unusual for a pilot to be given wind

forecasts based on raw data which is fifteen hours old. Certainly we can do better than this! Investigations have been undertaken which examined the feasibility of using INS equipped aircraft as a source of data for high altitude wind conditions. This work should be continued since initial results have proven promising.

While en route to a destination, the primary access a pilot has to real time weather information is through his airborne weather radar. Yet, the requirement for FAR 121 operators to equip with weather radar is somewhat tempered by an exemption for airplanes used solely within the states of Hawaii and Alaska. Weather data exists which indicates that thunderstorms and heavy precipitation are not all that uncommon in both of these locations. We are of the opinion that all 121 operations should be required to carry weather radar.

The FAA has made attempts to enhance the ability of pilots to obtain real time en route weather information, but in all reality they have had little success. For example, following the Southern Airways accident some years ago in Georgia, the FAA implemented a "Center Weather Service Unit" (CWSU) program for each of its Air Route Traffic Control Centers. While these facilities are staffed with professional meteorologists, their efforts are directed toward insuring that air traffic controllers in the Center and other ATC facilities within the Center's jurisdiction are informed about severe weather possibilities rather than providing this critical information directly to the pilot. Apparently the idea is that the pilot will benefit in the long run. Such is not always the case. The lack of standardization within these facilities and ineffective communications between the CWSU and other weather/aviation oriented facilities is a direct cause of system deficiencies. Whether the communications problem is procedural, or due to inadequate land lines, the result is the same. Likewise, if the CWSU, the FAA Central Flow Control Facility in Washington, D.C. and facility controllers do not talk to each other, the result is equally bad.

Another so-called en route weather aid is the "En Route Flight Advisory Service", referred to as EFAS. These facilities share one common frequency, and while they may provide a valuable service to general aviation aircraft flying at slower speeds and lower altitudes, they are of little value to air carriers operating at higher altitudes and faster speeds. The FAA has tested a high altitude version of this service in the Western United States and airline pilots who have used it commented very favorably on the service they have received. We understand that preliminary discussions relating to the frequency management problems associated with the high altitude EFAS program are now in progress. Our fear is that if they progress at the same rate other frequency management problems have, only our grandchildren may see the fruition of this program.

As stated earlier Mr. Chairmen, we have particular concern over the inability to get accurate information on severe weather conditions in close proximity to the airport. What is lacking is precise information on wind shear associated with down bursts, gust fronts, or low level jet streams and heavy precipitation. Because these phenomena are so localized and dynamic in nature, we need sensors that can acquire accurate data and then provide this information on a timely basis to flight crews. There are no systems installed at any airport today which can provide this service.

Mr. Chairmen, these are but a few of the deficiencies that exist in today's aviation weather services provided to airline pilots. Little has been done to

provide the pilot in the cockpit real time specific, short-term decision-making information. This situation must be corrected. While we certainly agree that air traffic control facilities also need similar data, it is only in the cockpit that all elements of the decision-making process can and must be available. Therefore, all near-term efforts in the area of aviation weather service should be directed toward this end. We strongly urge the following actions be taken:

1. That the FAA place priority action on the establishment of a high altitude EFAS program, and the capability for air carriers to communicate directly with Air Route Traffic Control Center Weather Service Unit meteorologists.

2. A program should be under taken immediately which would result in providing air carrier aircraft with a system capable of receiving ground-based National Weather Service radar presentations. Such a device would provide a pilot with valuable additional weather information to use in conjunction with other available data in his decision-making process. This is within the state-of-the-art today, but will only happen if it is mandated as were other significant safety improvements. Such information in the cockpit will be particularly valuable in the future when NEXRAD doppler radar is available.

3. Funds must be appropriated for installation of Doppler weather radar at those airports most effected by the severe weather phenomena described earlier. This radar should be short range (15 to 30 miles), capable of rapid update, and suitable for interface with a computer which would analyze radar data and convert this data into a message directly to the flight crew.

Mr. Chairmen, I would like to comment briefly on two new weather related systems the NWS and FAA are exploring. They are the implementation of an all-digital radar code planned for November 1982 and the NEXRAD radar.

The proposed all-digital radar code does not improve the timeliness or the accuracy of the weather observation transmitted in the Storm Detection (S-D) radar reports. The accuracy of the all-digital code has been called into question by several aviation user groups that have reviewed the proposed change. The objections are well founded and specific:

1. The all-digital codes have the potential to significantly overstate the size of any convective activity.

2. The size of the grid system proposed for the digital code is too large. Each grid is 22 mi. x 22 mi. The current AIRAN reports are utilized by organizations which require greater locational accuracy than that afforded by the proposed grid which has potential position indicating accuracy of locating a storm in an area no smaller than 484 square miles.

3. The proposal to delete reporting the percentage of areas effected by convective weather, if implemented,

would seriously diminish the quality of information contained in the S-D report.

4. As proposed by the NWS, the current practice of differentiating types of precipitation observed (rain, rain shower, thunderstorms, snow showers, etc.) in the AZRAN code is to be abandoned with the all-digital code. This would further reduce the quality of information available from the S-D reports.

The current S-D codes represent an essential source of information for the National Severe Storms Forecast Center to prepare convective SIGMETS.

These weather advisories serve to notify pilots of the possibility of encountering hazardous flying conditions which may not have been provided in preflight briefings.

Convective SIGMETS are the only source of warning information available to the vast majority of pilots in this country. The new all-digital radar codes will not be used as a basis for short period forecasts or warnings because they are not timely or exact enough for that purpose. How then does the National Weather Service propose to continue the Convective SIGMET Program? Further, how does the service reconcile the apparent need for accuracy in S-D special reports with the limitations of the proposed grid system?

Every aviation user group, aviation safety organization, and aviation regulating body which has reviewed this proposed change has found it to be severely deficient. The Administrator of the Federal Aviation Administration, the Chairman of the National Transportation Safety Board, the Air Transport Association, the Professional Airline Flight Control Association, and the Air Line Pilots Association have all recommended that the AZRAN portion of the weather radar observation be retained. The proposed abandonment of the AZRAN code would seriously compromise the accurate dissemination of weather information to the entire aviation community.

As for NEXRAD, ALPA strongly supports this program. Anyone familiar with the current NWS radar system cannot help but support a more reliable and vastly superior weather radar. However, we are concerned that the conceptual differences existing between the FAA, the NWS and the DOD regarding NEXRAD, may result in a system which will be goldplated, too expensive, and tied up in a lengthy R and D program, that either because of cost or technical problems will delay procurement and installation of this system. This program will have to be monitored closely in order to insure the implementation of a system that best fits aviation user requirements.

The last point I would like to make Mr. Chairmen, is about the obvious lack of direction in aviation weather services. Within the FAA, the responsibility for weather is so fragmented that there does not appear to be any direction to near-term services or a cohesive long-term program. The National Weather Service on the other hand claims severe budget reductions require that they transfer all aviation oriented weather tasks to the FAA. The airport weather observation program is a classic example of the bickering between these two agencies. FAA says they are getting out of the weather observation business, and the National Weather Service says they cannot afford to be in the airport weather observation business nor is it their responsibility. We strongly suggest, Mr. Chairmen, that both of these agencies be directed to work together until they can agree on a common direction for currently required and long term weather programs. And finally, Mr. Chairmen, whichever agency assumes the lead on this issue must be given adequate funding to support the necessary work which has been identified.

Captain CLYNE. Mr. Chairman, convective weather information is currently gathered by the NWS using about 200 storm detection radar sites located throughout the domestic United States. The information is sent via an azran code [azran refers to the method of describing the location of a thunderstorm]. It means literally azimuth—compass bearing—and range—distance from the observer. The National Weather Service proposes to do away with the azran code and substitute a new all-digital code.

The proposed all-digital radar code does not improve the timeliness or the accuracy of the weather observation transmitted in the storm detection—S–D—radar reports. The accuracy of the all-digital code has been called into question by every aviation user group that has reviewed the proposed change. The objections are well founded and specific:

First, the new digital codes have the potential to significantly overstate the size of any thunderstorm activity.

Second, the size of the grid system proposed for the digital code is too large. Each grid is 22 miles by 22 miles. The current azran reports are utilized by organizations which require greater locational accuracy than that afforded by the proposed grid, which can only show the position of a storm within an area of 484 square miles.

Third, the current azran code addresses the problem of reporting the convective activity in large areas by estimating that activity as a percentage—tenths—of the area affected. The users of this information have found these reports to accurately portray convective weather conditions as they actually exist. The proposal to delete this aerial coverage report, if effected, would seriously diminish the quality of information contained in the storm detection report.

Fourth, as proposed by the NWS, the current practice of differentiating types of precipitation observed—rain, rain shower, thunderstorms, snow showers, et cetera—in the azran code is to be abandoned with the all-digital code. This would further reduce the quality of information available from the storm detection report.

The uses to which these storm detection radar codes are put demand a great degree of accuracy. Storm detection reports are issued on an hourly basis by the National Weather Service. In addition, they are issued at any time one of the following conditions is observed:

First, radar echos of VIP 6 are observed—a level 6 storm would strike fear in the heart of the Red Baron.

Second, radar echos of level 4 or 5 storms are noted—this will quicken the pulse of Steve Canyon.

Third, storms are noted echoes tops approach or penetrate into the stratosphere, that is, a storm 10 miles high. These will quiver the lip of Smilin' Jack.

Fourth, radar echoes with characteristic hook shapes or holes—which suggest a tornado—are seen.

Thus, storm detection reports which the National Weather Service proposes to change to an all digital format do not deal with trifling matters.

The current storm detection codes represent an essential source of information for the National Severe Storms Forecast Center to prepare convective sigmet reports.

Allow me to quote from the Airman's Information Manual:

> These weather advisories, sigmets, serve to notify en route pilots of the possibility of encountering hazardous flying conditions which may not have been provided in preflight briefings * * * [sigmets] will be issued for the following phenomena: First, tornados; second, lines of thunderstorms; third, embedded thunderstorms; fourth, thunderstorm areas greater than or equal to thunderstorm intensity level 4 with an area coverage of 40 percent or more; and fifth, hail greater than or equal to ¾-inch diameter.
>
> Note: Since thunderstorms are the reason for issuing the convective sigmet. Severe or greater turbulence. Severe icing and low level wind shear—gust fronts, etc.—are implied and will not be specified in the advisory.

Contrary to common belief, most noncommercial and some air carrier aircraft are not radar equipped. Sigmets are the only source of warning available to the vast majority of pilots in this country. The information contained in these sigmets is vital for the safe conduct of a flight.

The National Weather Service has stated that the all-digital codes are not to be used as a basis for short period forecasts or warnings because they are not timely or exact enough for that purpose.

One can only wonder how the National Weather Service proposes to change to the all-digital code and still continue with the convective sigmet program without severely degrading the program. This appears to be an impossible contradiction.

Every aviation user group, aviation safety organization, and aviation regulating body which has reviewed this proposed change has found it to be severely deficient. The Administrator of the Federal Aviation Administration, the Chairman of the National Transportation Safety Board, The Air Transport Association, the Professional Airline Flight Control Association, and the Air Line Pilots Association have all recommended that the azran portion of the weather radar observation be retained. The proposed abandonment of the azran code would seriously compromise the accurate dissemination of weather information to the entire aviation community.

As for Nexrad—which stands for next generation radar—ALPA strongly supports this program. Anyone familiar with the current NWS radar system cannot help but support a more reliable and vastly superior weather radar. However, we are concerned that the conceptual differences existing between the FAA, the NWS and the DOD regarding Nexrad may result in a system which will be gold-plated, too expensive, and tied up in a lengthy R&D program, that either because of cost or technical problems will delay procurement and installation of this system. This program will have to be monitored closely in order to insure the implementation of a system that best fits aviation user requirements.

Mr. HOWELL. Thank you, Pat.

At the risk of elevating blood pressures once again, the last point we would like to make, Mr. Chairman, is about what we perceive to be a lack of direction in aviation weather services. Within the FAA the responsibility for weather is so fragmented that there does not appear to be any direction to near-term services or a cohesive long-term program. The National Weather Service, on the other hand, claims severe budget reductions require that they transfer all aviation oriented weather tasks to the FAA. The air-

port weather observation program is a classic example of the bickering between these two agencies.

FAA says they are getting out of the weather observation business, and the National Weather Service says they cannot afford to be in the airport weather observation business, nor is it their responsibility. We strongly suggest, Mr. Chairmen, that both of these agencies be directed to work together until they can agree on a common direction for currently required and long-term weather programs. And finally, Mr. Chairman, whichever agency assumes the lead on this issue must be given adequate funding to support the necessary work which has been identified.

Thank you, and we will attempt to answer questions you have.

Mr. GLICKMAN. Do you want to show your video now or do you want to wait?

Mr. HOWELL. It may depend on the nature of the questions. I think once we embark on the video we will be opening a different area for discussion.

Mr. GORE. We will wait on that one.

Mr. GLICKMAN. First of all, thank you for your testimony very much. Let me go for a moment to my question to the FAA. I was reading from a Washington Post story regarding the New Orleans crash. The only point in my reading it was that apparently there was information available regarding wind shear, but there were mixed signals on what that information was, how relevant it was, and what were you going to use the information for once you got it.

I wonder if you could comment on the whole—let me just read it to you. Are you all pilots?

Mr. HOWELL. Yes, sir.

Mr. GLICKMAN. OK. The tower reported shear in all directions around the airport 6½ minutes before the accident. We have a low-level, wind-shear alert in all quadrants, the controller said. Appears to be a frontal storm passing overhead right now. We are right in the middle of everything. Ten minutes before the crash the pilot of another plane landing on the same runway the Pan Am plane used said you have got a 10-knot wind shear on runway 10. The information was passed on to other planes in the area. Weather radar indicated severe thunderstorms all around the New Orleans area right at the time the accident occurred. As a pilot, what responsibility does he have once he gets this kind of information? It is totally, completely and 100 percent exclusively in his discretion as to whether to go or no go? And did he have enough information available to him at that time to make an intelligent decision?

Mr. HOWELL. As parties to the investigation we do not wish to comment specifically on the accident. But nevertheless your question can be answered, I think, without necessarily touching on the specifics of the current investigation. With respect to the responsibilities of the pilot in command, I think we all agree the cockpit is the focal point of the information and the decisionmaking process. The captain is the individual who must make the determination as to go or no go. It is a function of two things at that point. One, the information he has on hand, and, two, the professional judgment that he brings to the scene. This is why we feel that the distribu-

tion of timely information is a critical element to help him in that judgmental process.

We further hope that through training and his other line experiences, which are both pretty significant to bring him to that left seat, he would have the ability to use that information and to make the proper judgment at that time. But he does indeed have that responsibility.

Mr. GLICKMAN. There seems to be some feeling that perhaps this pilot, or other pilots in general, may disregard or not regard as being terribly significant, advisories on low-level wind-shear warnings, meaning that maybe they don't think, or you don't think they are reliable indications of what the problems are. I guess what I am saying is that we are spending hundreds of millions of dollars on technology. I want to make sure we get something that is worth something.

Mr. HOWELL. Yes, sir. We are very pleased that the low-level wind-shear alerting program is in progress. But it is not the ultimate answer. At the outset it might be fair to say that the threshold of warning at the moment is set a little too low. Furthermore, we need to support the information provided by the low-level wind-shear alerting system with other information.

Now I have asked Captain Melvin to come with me today because his work in our Airworthiness and Performance Committee has dealt with wind shear at length.

Bill, would you have further comment in this area?

Captain MELVIN. Thank you. The information of the wind-shear alert, set at 15 knots, is really an automatic monitor that the control tower uses to advise them that there is a 15-knot vector deviation in the wind. At that time the control tower should actually monitor the wind and give the actual wind levels to the pilot. In other words, there might be a 40-knot deviation. It is the transmission of wind-shear alert with only the ringing of a bell. And without giving the specific detail——

Mr. GLICKMAN. All you know is that the threshold has been reached, but you don't know anything over that threshold.

Captain MELVIN. Right. There will be many times when pilots, you will have controlled fronts passing an airport or something. You will have some deviations. The pilots will know very well that they are not going to exceed the performance of the aircraft in operating that condition.

Also, there are training problems. There are problems with NTSB reports that say that, yes, the airplane crashed, but if the pilots had had the right stuff they would have made it through there. There are training programs that imply that pilots properly trained can fly through wind shear. If you apply proper increment, that you can—it is safe. We have been steadfastly insisting that the worse and most severe types of downbursts and microbursts cannot be flown through with a commercial transport aircraft in the takeoff and landing configuration.

Mr. GLICKMAN. So what you are basically telling me is you think the wind-shear information while useful is inadequate?

Captain MELVIN. It was inadequate probably in this case, and probably—what we have said is that the pilot makes judgment on the information, and also his risk assessment. Sometimes his risk

assessment is not—is tainted somewhat by people implying to him that he can successfully fly through these encounters.

Mr. GLICKMAN. People implying? Do you mean the tower implying or other pilots implying?

Captain MELVIN. I will give you an example. In the accident report on the Allegheny DC-9 crash in Philadelphia, the airplane impacted the ground with a 10-G vertical impact. NTSB said that however, if the pilot had used all of the performance available in the aircraft he probably could have flown through it. Well, that is impossible. It implies that those pilots with the right stuff can try this on all the time. In other words, it has always been pilot error in every one of these cases. There are really some shears out there that are too strong to be flown through. That is not the only report that contains such misleading analysis.

Mr. GLICKMAN. Captain Howell?

Mr. HOWELL. Two interesting parallels come to mind. One has to do with the ground proximity warning system. In the early days when the technology was brand-new there were oftentimes when the pull-up signal may have been heard in the cockpit. There was a brief period of analysis while the crew checked several parameters. With the maturing of that technology nowadays that reaction time is much diminished.

At the other end of the spectrum is the announcement by a controller in an approach to a terminal area, "caution, wake turbulence, preceding aircraft is heavy." We have heard that so much now that there is little regard for it. But we will soon be moving to where we are trying to work with that. So we now have—we are in the same kind of problem midway between the limits there with the low-level wind-shear alerting system.

Mr. GLICKMAN. Now, let me ask you another question. If you could measure wind-shear velocities more accurately than we can now at levels of, you know, you talked about 40 or 50, or whatever, do you think that we could come up with some information specific enough to have minimums and maximums like we do on ceilings and visibility?

Captain MELVIN. We think there could be. But ceilings and visibility are really operational limits. In other words, the airport is not closed by the tower. They give a RDR or they give a level with an instrument that is accurate and the pilot determines whether it meets his operational limitations. I think that this is probably where we would like to go with this, with this type of instrumentation.

Now, it is unfortunate that in almost every wind-shear accident there has been sufficient evidence that should have prevented the operation. We discover this all after the fact. We have recently proposed a means of assigning risk level of certain meteorological conditions. And at a certain risk level, which we have—it is an ALPA proposal only.

[Discussion paper on a proposal to limit risks from wind-shear encounters follows:]

DISCUSSION PAPER ON A PROPOSAL TO LIMIT RISKS FROM WIND SHEAR ENCOUNTERS.

Transport category aircraft accidents are rather rare and taken altogether prove an impressive safety record. Many would use gross statistics to argue that no new regulation, or system or standard should ever be imposed because the costs would not justify the benefits. However when accidents and incidents are evaluated according to the risks that were being taken at the time of each operation there is overwhelming evidence that limiting the highest risk operations would in fact prove to be very cost effective.

In almost all wind shear related accidents and incidents there was evidence before the event that in retrospect should have prevented the accident/incident if the evidence had been collected and disseminated in a timely manner to the flight crews and if the flight crews had recognized the risks involved.

According to the above rationale, I am proposing for discussion a system to rate the wind shear risks for various meterological conditions which could limit the highest risk operations while not imposing an undue economic burden upon operators such that the limits would be ignored.

What is proposed is to establish levels of risks along the following lines:

LEVEL 1. Meterological conditions not conducive to wind shear. Basically clear and nearly calm winds--5 knots or less. This level would not be transmitted to pilots unless there was a pilot request for the wind shear level.

LEVEL 2. Some wind shears. Surface winds from 5 to 20 knots. Orographic shears, nocturnal jet stream, general gustiness. Well within capability of aircraft performance. There would probably be some wind shears reported at this level. Level 2 would not be transmitted unless there was a report of a wind shear and then only to inform pilots that the risks of encountering a shear that would exceed their aircraft performance would be very small.

LEVEL 3. Surface winds 20 to 40 knots. Wind shears approaching limit of 1 knot per second in horizontal plane. Greater than 10 knot variations in airspeed reported by pilots. Shears associated with frontal conditions. Although these shears are within the capability of aircraft performance, they can be hazardous if not immediately

identified and corrected for. Level 3 and subsequent levels should be transmitted on the ATIS and given as advisory information by the tower.

LEVEL 4. Wind shears beyond the capability of jet transport aircraft to correct for without an energy trade are a possibility. Vertical development of clouds with cell activity within 10 nm of an airport. Reasonable expectation of a downburst or microburst. Excess energy recommended for all aircraft. At this level all persons should be keenly tuned to search for further evidence which would confirm the presence of a microburst or downburst. Surface winds in excess of 40 knots should also be classified as Level 4 because there is a high pobability that orographic shears could exceed aircraft performance capability.

LEVEL 5. Vertical development with presence of microbursts or downbursts confirmed by (1) ground instrumentation, (2) aircraft instrumentation, (3) aircraft encounter (missed approach, hard landing, etc.), (4) visual sighting (ring of dust, etc.), (5) other information. Level 5 should be automatically assigned if a cell is within 5 nm of the airport unless the airport has an approved ground detection system that is capable of identifying microbursts, in which case operation could be continued as long as arriving and departing aircraft could remain more than 3 nm from any cell while below 1000 feet agl. At Level 5 operations should be suspended until observations indicate the level can be downgraded to 4.

No prudent pilot should attempt to takeoff or land at Level 5 unless other risks are predominant, such as low fuel state, etc.

The assignment of the levels 1 through 4 should be done by a meterologist. Level 5 would be automatic if any source of information indicated the presence of a microburst or downburst.

Consideration should be given to an automatic "Wind Shear Alert--Level 5" transmitted on tower frequency when Level 4 has been assigned and ground instrumentation confirms the presence of microbursts/downbursts or if an air traffic controller activates the automatic transmission. "Wind Shear Alert" should not be transmitted to pilots just because the alert system in the tower alerts the controllers to the fact that there is a 15 knot variation in wind. In this case the actual wind values should be transmitted to pilots. A higher value than 15 knots should be used for an automatic alert. Otherwise pilots will tend to ignore the warnings as they will occur frequently when they do not indicate the presence of a microbursts or downbursts.

An automatic alert feature could possibly be transmitted to ACARS for transmission by data link to all aircraft so equipped in the area. ACARS could activate a voice alert in the cockpit.

Mr. GLICKMAN. This is an ALPA proposal?

Captain MELVIN. Yes, it is. It is being sent to the industry. This would say at risk level 4 you are operating in a known meteorological condition conducive to microbursts and downbursts. When operating in that condition, any other piece of evidence that would conclude that there was a downburst or microburst would be an automatic assignment to a risk level 5, which would be to discontinue operations. There is evidence it has frequently been there. In other words, in most of the cases where we have had landing accidents with wind shears the pilots of the preceding aircraft have made missed approaches and have almost crashed. I could name you a half dozen of them.

There are cases where rings of dust have gone past the airplane which was clear evidence of a dust front that was not recognized. So this is one place where we can make some immediate improvement.

We can also make immediate improvement in the simulators with the training programs. Unfortunately, many of the profiles that are in the simulators are in there to teach pilots some kind of magic technique to fly through a wind shear. They do not properly impress upon the pilot that there are wind shears out there that you cannot fly through.

Mr. GLICKMAN. I think those are very useful comments that you have made to us. I would be interested to know if your proposals on risk levels receive any interest either from the industry or from the FAA, because this is one of the most serious of all weather-related problems, the issue of wind shear. We continue to keep having them. That is the thing that worries me. Let me ask you just one final question that goes back to pilot control.

Many times I have been at airports, busy airports like Washington National, New York's La Guardia, weather conditions have been scary. I don't know if they are marginal, but they are to any passenger who sees lightning outside and sees heavy rain, and you know some planes are taking off, some planes are not taking off. I have talked to pilots about that. Basically, you know, they have told me that it is ultimately their judgment as to whether it is safe or not. The question as to whether approach and departure stop operations criteria should be issued in this kind of weather is one that has been asked of me before.

Should the FAA, or should airports have that kind of discretion? I wonder if you might comment on that.

Mr. HOWELL. We are of the opinion that we should be the people to make the determination as to whether or not a specific operation should occur. However, we must have the guidelines to follow. That is to say, as Bill mentioned earlier when he was discussing ceiling and visibility, each of us has different limitations for operations which are governed by ceiling and visibility. So when you see one aircraft depart in a foggy condition, it may be because he has specific operating characteristics of his airplane, or equipment, or an additional experience level.

For example, we have come captains which are so-called high-minimum captains. Their weather minimums are higher than more experienced persons.

Mr. GLICKMAN. Wait a second. That implies to me they have a lower level of capability. I mean I would be nervous if I were flying with a high-minimum pilot. What exactly do you mean there?

Mr. HOWELL. A doctor in his first operation.

Captain MELVIN. That is not really true, as a matter of fact. There is one airline that has a petition before the FAA right now to change that. Actually, the captain who has just completed his checkout with 25 hours of simulator training and/or flying is more qualified to operate at low minimums than he will ever be in his life, because he has been doing it for a couple weeks.

But the regulation says that until he has 100 hours in his plane that he is a high-minimum captain. So it doesn't mean he has less experience, and certainly not less ability, because from my own experience I know that when I have finished that training ride I can fly the ILS like a greased rail.

Mr. GLICKMAN. I don't want to imply to the flying public that there are certainly pilots flying who are less qualified than other pilots. That may in fact be the case as with Congressmen. But at least in terms of going through the certification procedure.

Mr. GORE. Well, this is an even numbered year. [Laughter.]

Mr. GLICKMAN. Thank you, Mr. Chairman.

Mr. GORE. I just have a few brief questions. You said that the FAA is disorganized when it comes to weather as a causative factor. Would you support a recommendation from these subcommittees that the FAA establish a senior position filled by someone who is responsible for weather as a causative factor?

Mr. HOWELL. Yes; I think the weather conditions across our country are so diverse, the aircraft operations we are now involved with are so diverse that it would indeed warrant such a focal point.

Mr. GORE. All right, very good. Now in all the discussion about the pilots' role in these accidents, there always seems to be an indication that a pilot is under a good deal of pressure from circumstances, from the way the system is designed, to go ahead and take off, to go ahead and land in spite of weather conditions.

Does such pressure exist?

Mr. HOWELL. Undoubtedly the pressures are there, such is the nature of the job. We are a very go-oriented industry. Nevertheless, I would be remiss if I led you to believe that these pressures overcame a professional and competent pilot's decisionmaking process for a no-go.

Bill and I were discussing that very kind of thing yesterday. Bill, you had some interesting points to make with respect to judgment.

Captain MELVIN. If I may.

Mr. GORE. Mr. Melvin, you are probably as knowledgeable as anybody in the United States on this weather problem. Is the pilot under a lot of pressure to go in spite of it?

Captain MELVIN. I personally am not, and most of my friends are not. What you are speaking about really is the reason why the Air Line Pilots Association was formed in the first place.

Mr. GORE. Excuse me? Say that again?

Captain MELVIN. The types of pressures you are talking about, for pilots to make decisions against their best judgment for safety is really the basic reason why the Air Line Pilots Association was founded. We in the companies where we have strong representa-

tion, we do not tolerate that, nor do we expect that responsible management will engage in it. I personally do not think that is the problem that it has been played up to be in the press. I have in 22 years with a major air carrier, never felt any pressure put on me questioning my judgment involving operational safety of the aircraft.

Mr. GORE. Well, we have reviewed this matter. And we found no instance where a pilot was ever disciplined or encountered any kind of bad personnel action when they had a no-go. But do you know of such instances?

Captain MELVIN. Well, unfortunately there was a case, I think it was on Mohawk, about 10 years ago, where one or two pilots refused to take the airplane up because of a particular condition. These pilots were disciplined. In that case the FAA did not back the pilots up on their captain's authority. We were very, very disappointed when that happened. It hasn't happened recently. It is funny how when an accident occurs the captain has a great deal of authority. But recently there was even a proposal from the FAA on duty time limitations that said that after a pilot had flown over 8 hours in a given day that the vice president of operations of his air carrier would decide whether he was too tired to fly or not. Of course we won't tolerate that, and I don't think that will become a regulation. But that is an obvious encroachment on the captain's authority to determine safety of the flight.

Mr. GORE. It is obviously quite premature to ask you all to respond to what the National Transportation Safety Board is finding with respect to Air Florida. And they have spent a lot of time and a lot of work on that incident. But to fix the principal blame on the pilot there, of course, they are still meeting today and a lot is still coming out. You may not wish to respond. We won't press you on it if you don't want to. But it does seem with the spacing of the airplanes, the apparently improper deicing procedure, the evident problems with the airplane that was associated with similar problems in gaining altitude on takeoff in other incidents, that a complex of circumstances was created that made the consequences of an error in judgment much more severe than they might otherwise have been. Pressures to make that judgment on the side of taking off were, it seems, pretty intense.

Now that is my characterization and I am not a pilot, and I haven't sat through all of the testimony that the NTSB sat through. But if you wish to comment, I will give you the opportunity to.

Mr. HOWELL. Initially I would have to say that we are a bit baffled by how they could so callously say pilot error was the sole factor in this accident. I recognize it is difficult to characterize the cause of an accident in a single paragraph or one or two sentences. Beyond that I would have to say that I look forward very much to seeing what recommendations come out of this for our operations. These accident investigations should be a learning process. When you say pilot error, period, full stop, we don't benefit from any of the learning processes.

We shall be looking at the recommendations that emerge today, and how they indeed support or relate to the findings of the Board.

Then we shall be reviewing the process by which the Board arrived at its ultimate probable cause findings.

Bill, would you have anything to add?

Captain MELVIN. I would like to respond. I think one of the major problems with aviation safety is the system we work under where the FAA treats identifiable human error as criminal negligence. This makes it impossible to fault-monitor their system. This is the reason why time and again they do not know of the incidents and near accidents with things that happen or could have happened until after the fact, because no one is willing to say I almost crashed an airplane.

Now in this case there was evidence of problems with the airplane. There has got to be some question of whether this crew was aware of the information of the bad performance characteristics of this aircraft with ice. As was discovered by the British who made special operating conditions on it, there has to be some question about the instrument display that the crew had because it is very probable and likely that the erroneous information caused the flight recorder to indicate high airspeed and high altitude, was also showing the same indications on the cockpit instructions.

It is very possible that that happened, which would indicate that with the stick shaker, that you should have the case that we have so many times of a false stick shaker and not false instruments.

It also should be pointed out, and I hope would be a recommendation that the sensor that drives the stick shaker is an angle of attack sensor. It has all the logic and all the measuring capability providing an accurate angle of attack display in the cockpit, which would have been additional information and is very important in optimizing performance of aircraft, which we do not have available. They are in light aircraft, but not available in our aircraft.

Finally, I am very disappointed in the last nail in the coffin that says that the pilots could have made it if they would have had the right stuff. That is indicative of the accident reports we have seen time and time again on wind shear, where they go through an analysis and they say how bad it was. Then they say yes, but if these guys had really done it right, they would have still made it.

Thank you.

Mr. GORE. Well, thanks for that response. It is almost unfair to ask you to comment, you know, while they are still in proceedings. But I appreciate your willingness to do so. I would refer people reading this record to the testimony in our earlier hearing of Mr. C. O. Miller, who was a former NTSB investigator, now a lawyer, who identified, we asked him to single out the most important aspect of the problem. He had a very eloquent response. I can't say it as well as he did. But to paraphrase it, it was the relationship between all the elements of the air transportation system and the possibility of human error, and how it, the way the system forgives or fails to forgive human error, and consequences become as a result of the system. You are not going to avoid human error in any complicated system like air transportation.

Certainly the NTSB report did not say period, full stop. I mean it is a better—it is a much more sophisticated report. As I said earlier, it is still to fully come out. Hopefully we will get some good recommendations out of it today.

Now, I wanted to ask you briefly about the cockpit wind shear detection equipment and whether or not you foresee that in the near future.

Mr. HOWELL. Captain Melvin again, please.

Mr. GORE. That will be my last question.

Captain MELVIN. The cockpit sensing devices can alert pilots to the fact that they are in wind shear. There is one device that stores energy. That is very dependent on accurate ground reporting wind in which case if you have accurate ground reporting wind you really don't need a computer to tell you what to do with your aircraft. These devices would probably allow pilots to optimize performance, and perhaps avoid some hard landings and some accidents in a band of wind shears. That is, somewhere in the moderately severe shears.

However, none of the cockpit instruments that we are talking about help you avoid the most significant encounter. These instruments will not allow you to fly through those encounters. In other words, you can't put an instrument on an airplane, the ones that we are familiar with, and fly around with the idea that you are protected from wind shear, because the most—the worst encounter, then, still you will not be able to fly through it.

So while we are not against this type of instrumentation, and we know of reasons why pilots underreact to wind shear, and there is a physiological reason due to the inertial acceleration I won't go into, but there are reasons why they tend to underreact to shears, this type of sensing will alert the pilot to the magnitude of the shear, and perhaps quicken his responses. But it won't prevent wind shear accidents of the worst kind.

Mr. GORE. Well, now you had a demonstration of this cockpit wind shear detection equipment? Wait a minute. That is the onboard Doppler. Is that correct? You had a demonstration for us. I am trying to find the question that triggers——

Mr. O'BRIEN. Basically, this is not our demonstration. This particular Doppler ground-based radar technique was presented to us sometime ago. We were very impressed with the capabilities of this particular system, and we brought it to the attention of the committee staff. It was through this mechanism, I believe Mr. Hansen is available today, to present some information on the ground-based radar Doppler technique.

Mr. GORE. Why don't we look at this briefly, then we will break for lunch right after this film until about 1:30.

Mr. GLICKMAN. We may need to turn it off in the middle—if you don't mind.

Mr. HANSEN. First, Mr. Chairman, I am Art Hansen, consultant in meteorological radar. I was involved in NOAA for about 10 years in various radar and display communications systems. In fact, my last job was as director of the Nexrad program for the National Weather Service.

Mr. GORE. Mr. Hansen, we want to welcome you. The airline pilots have steered you in our direction. We will put the statement you have provided in the record. I would ask you, if you could, to sort of briefly summarize it and tell us what it is we are about to see.

Mr. HANSEN. Yes, there are presently three Doppler weather radars used operationally in the United States. One is in operational tests at the National Weather Services offices at the Montgomery Airport. The other two are at television stations, one in St. Paul, Minn., the other in Oklahoma City. I have videotapes from those three radars which I would like to show you today.

These radars measure not only the intensity of the rainfall but can measure the windspeeds toward or away from the radar. I would like to show the pictures. Is this a proper position?

Mr. GORE. Yes, fine.

Mr. HANSEN. First, to give you some background on what Doppler weather radar does for you, I am showing only the wind information and not the intensity information. The velocities toward or away from the radar are shown in a spectrum of colors. The white indicates very little velocity toward or away from the radar. The radar is located, in this particular picture, in the center. The storm is moving to the northeast.

The colors blue, progressing through green up to red are progressively higher velocity winds moving toward the radar. They are of higher velocity because of the radar angle. The radar is looking up above the horizon, so we are looking at upper level winds. All of these winds would not be measured on the ground. On the eastern side of the radar we are measuring velocities away from the radar, again in progressively increasing velocities. I have scenes from downbursts, wind shear and mesocyclones.

The first scene is a picture taken from the KSTP television radar, located in the center, looking at a thunderstorm. The area in green is of particular interest. At ground level, this shows the wind toward the radar at about 30 miles per hour. The radar was then pointed up in the storm and high level winds of about 60 to 70 miles per hour were measured and were tracked down to ground level. When they hit, the speed was confirmed on the ground at about 67 miles per hour. This I would interpret as a downburst.

The second scene is a scene from Montgomery Airport, this is a videotape taken by the National Weather Service. This is a downburst near the airport and near the end of the runway. The airport and radar are located here. This blue indicates velocities toward the radar and yellow and orange indicates velocities away. I would interpret this as a downburst and it was moving toward the airport. An advisory was issued by the NWS to the air traffic controller about 15 minutes prior to this wind shear reaching the airport.

The next case is a gust front northwest of the airport. The radar is located in the center. It is moving toward the airport at about 50 miles per hour. The meteorologist can zoom in on the picture and expand the whole top part of the picture. This high speed wind did move toward the airport and an advisory was issued to the airport.

Mr. GLICKMAN. All we are seeing is wind? We are not seeing precipitation in this particular picture, is that correct?

Mr. HANSEN. That is correct. There is precipitation associated with the echoes but the colors do not relate to the intensity. A separate display is used to depict the intensity. This is strictly the windspeed.

Mr. GORE. This is operated by television stations?

Mr. HANSEN. Two television stations and National Weather Service at Montgomery Airport.

Mr. GORE. Is this something that has come out of TV news to try to make the weather portion of the news better than the competition? Is that how this developed?

Mr. HANSEN. There is a definite market in the television industry for weather. The new generation in weather radars requires the measurement of windspeed because windspeed is how you determine whether a storm is severe or not.

Mr. GORE. But that is where the money for this cutting edge technology is coming from; is that correct? TV weather?

Mr. HANSEN. The first two radars that were installed, were really kits installed on existing radars. They were at television stations.

Mr. GORE. OK.

Mr. HANSEN. This is another incident of a high speed wind shear indicated by the red. It moved toward the airport. The details of these are in the recorded statement I handed in. This moved toward the airport. In each of these cases there were warnings on the order of 15 to 60 minutes. In some of these cases there were winds as high as 60 miles per hour where trees and powerlines were downed in the city. The gusts were measured at the airport and nearby Maxwell Air Force Base.

This is July 11 of this year, 1 month ago. This is one of particular interest. The white indicates that the relative motion of this storm is very slow at the airport. The airport is at the center. This blue indicates velocity toward the radar and the orange, velocity away. So I would interpret this as a downburst very near the airport.

An aircraft taking off into this would have headwinds followed shortly thereafter by strong tailwinds.

Mr. GORE. You are inferring downburst from the proximity of the air moving in one direction to the air moving in the opposite direction?

Mr. HANSEN. Yes, sir.

Mr. GORE. You don't actually see a downburst. You infer it from the measurements?

Mr. HANSEN. I infer it from the measurements. On the first scene the radar, I believe, did see the downburst coming from the top of the storm because the radar, that is, the antenna was pointed up. This scene is looking at the effects on the ground of the downburst. That is the wind moving out from the point of impact. Nearby is an area that is the opposite. This velocity is away and toward, indicating inflow into another part of the same storm, or a separate storm.

This is another incident where an aircraft taking off in a northwesterly direction would have encountered wind shear in this area as indicated by velocities toward and velocities away from the radar. This is an expanded sector with the radar at the bottom of the screen. This again was at Montgomery Airport.

This is a picture taken by KSTP Television in St. Paul. It is a mesocyclone, a large thunderstorm about 40 miles north of the radar. A mesocyclone is indicated by the indicated velocities in this corner of the storm, velocity away, opposed to velocity toward, indi-

cating a rotation. The station detected this and issued a warning that a mesocyclone had been detected and the Weather Service reported tornadoes below that storm about 16 minutes later.

A similar system is in operation in Oklahoma City, KWTV. This is Gary England explaining detection of two simultaneous mesocyclones. The Weather Service had reported tornadoes associated with this mesocyclone and a funnel cloud was noted by the police department in association with this mesocyclone.

So the indication here is that there is an operational tool that is available. It is available as either a retrofit kit to existing systems or new radars and if dedicated to the airport safety problem, could I believe, help with aviation safety around airports.

[The prepared statement of Mr. Hansen follows:]

STATEMENT OF
ARTHUR L. HANSEN, METEOROLOGICAL RADAR CONSULTANT
HYDRO/NET LTD., 726 Lawton Street, McLean VA 22101

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U. S. HOUSE OF REPRESENTATIVES

AUGUST 11, 1982

DOPPLER WEATHER RADAR

Good morning, Mr. Chairmen and members of both Subcommittees. I am Arthur Hansen, a consultant in meteorological radar. I was involved in weather radar, display and communications systems in N.O.A.A. for 10 years. My last job with N.O.A.A. was as director of the NEXRAD program. For the last year I have been a consultant to Enterprise Electronics Corporation which manufactures most of the ground based weather radars in the world. I appreciate the opportunity to show you the capabilities presently available in production Doppler weather radars and how these radars can detect hazardous winds when they are associated with precipitation.

There are presently three Doppler weather radars used operationally in the United States. One is at the National Weather Service Office at the airport in Montgomery, Alabama for operational evaluation, and the other two are at television stations in St. Paul and Oklahoma City for use in local weather broadcasts. These radars have the same basic capabilities as the local warning radars of the National Weather Service plus the added capability of measuring wind speeds.

The users of these Doppler radars detect hazardous wind

conditions and are able to issue warnings to their communities. The NWS at Montgomery also issues warnings to the Air Traffic Controllers at the Montgomery airport. The Weather Service in Montgomery has issued warnings that would not have been made without the Doppler radar and in other cases have avoided issuing false warnings that would otherwise have been issued without the Doppler radar. The Doppler weather radar has provided information and a level of discrimination not previously available.

Gentlemen, the point that I want to make is that there are operational tools available which can detect wind shear when there is associated precipitation. Wind shear can be detected before it reaches the vicinity of an airport so warnings can be issued before the danger is encountered by aircraft.

Tests at the FAA Technical Center, NCAR and NSSL have shown that with a larger antenna and better signal processing, wind can be measured in moist clear air at short ranges (on the order of 6 to 10 miles). The manufacturer of the radars which are being described today is currently working with MIT engineers to develop a processor which will reduce ground clutter and further improve resolution and sensitivity. The first unit will be be ready for test this fall. Larger antennas are available which would complete the radar system which will meet most airport terminal area requirements. A computer system could be added to reduce the warning time and perhaps transmit the needed data directly to the pilots.

I agree with the recommendation of Mr. Howell, of the Air Line Pilots Association, that short range radars, capable of rapid update should be provided at major airports, dedicated to flight safety in the airport terminal area. The FAA should persue the possibility of using computer generated voice broadcasts to airborne pilots which may be added after more experience is obtained in the operation of these radars.

I would like to show you video tapes taken from these three operational Doppler radars, but first I want to explain the types of displays involved. The Doppler radar has the same type of intensity display as a non-Doppler radar. The intensity picture is like that seen in weather presentations on TV where different colors depict varying levels of precipitation. The Doppler radar provides a second type of picture where colors depict varying wind speeds toward or away from the radar. The colors in this second display indicate the speeds of the precipitation particles. The meteorologist uses both sets of data in making his warnings.

(Explanation of the Doppler video picture)

Now I would like to show you video tape recordings from these three radars. The images are of the Doppler (depicting wind only) presentations. The nine scenes depict various types of hazardous winds, including gust fronts, downbursts, and mesocyclones.

(Start video tape on Doppler weather radar)

Scene 1--Low level winds below thunderstorm measured (by radar) at about 30 mph. KSTP-TV video.

Scene 2--High level winds in same thunderstorm measured by radar at between 60 and 70 mph. This downburst was tracked to ground level by radar and confirmed by the annemometer at the station. KSTP-TV video.

Scene 3--Example of wind shear caused by a downburst near airport at Montgomery detected by radar. NWS issued warning 19 minutes in advance of event at airport. Date June 12, 1982. NWS video.

Scene 4--50 mph gust front moving toward radar at airport in

Montgomery, Alabama. 49 mph winds measured at airport and 40 mph winds measured at Maxwell AFB. Trees and power lines were downed in Montgomery. 15 minute advance warning for airport was issued by the NWS. Date June 4, 1982. NWS video.

Scene 5-Gust front moving toward airport in Montgomery. NWS detected gust front 60 minutes prior to reaching airport and issued wind advisory. Date July 11, 1982. NWS video.

Scene 6--Two areas of wind shear near Montgomery airport. Wind at airport was near calm. Wind shear just north of airport is shown by the radar to consist of headwinds near airport with tailwinds a short distance north (assuming a northerly flight direction). This was probably a downburst. The second windshear is seen to the east of the airport. Date not logged. NWS video.

Scene 7--Strong winds in northerly direction associated with thunderstorm near Montgomery airport. Wind shear is indicated to the northwest of the airport. Date July 21, 1982. NWS video.

Scene 8--Mesocyclone near St. Paul which developed tornado 16 minutes after detection by KSTP-TV Doppler radar. Main part of storm is shown in white, and circulation in lower left corner is shown by colors showing velocity away from the radar closely coupled with a velocity toward the radar. The warning was given 16 minutes in advance of the sighting of a tornado in this storm. Date July 2, 1981. KSTP-TV video.

Scene 9--Two simultaneous mesocyclones near Norman, Oklahoma. Circulation is indicated in lower left corner of each storm. Only three colors were used to simplify presentation to TV audience. KWTV-TV video and audio.

Mr. GORE. Thank you very much. That is fascinating. We have got three more witnesses that we will have after lunch, John Connolly, National Weather Service, retired; Paul Kadlec, an airline meteorologist manager; and Richard Hallgren, Director of the National Weather Service with NOAA.

Excuse me, before we—let me thank all of our witnesses very much for excellent testimony and let me invite our guests to return after lunch. At 1:30 we will reconvene in this room.

[Whereupon, at 12:30 p.m., the subcommittees were recessed, to reconvene at 1:30 p.m., this same day.]

AFTERNOON SESSION

Mr. GORE. The subcommittee will come to order.

We will proceed with the hearing and hear from our next witness, Mr. John W. Connolly, with the National Oceanic and Atmospheric Administration retired. Mr. Connolly, if you will come to the witness table, we are delighted to have you.

Without objection, the text of your written statement will be put into the record and if you care to summarize any portion of your statement, feel free to do so.

Please proceed.

STATEMENT OF JOHN W. CONNOLLY, DIRECTOR, GOVERNMENT AFFAIRS, ALDEN ELECTRONIC CO. (FORMERLY SPECIAL ASSISTANT FOR AVIATION AFFAIRS TO THE ADMINISTRATOR OF NOAA)

Mr. CONNOLLY. Thank you, Mr. Chairman.

Although my statement is short I will summarize it in the interest of time.

Mr. Chairman, it is a pleasure to appear before the subcommittees today.

From 1972 until 1979, I was Assistant for Aviation Affairs to the Administrator of the National Oceanic and Atmospheric Administration.

I was intimately involved in the subject under discussion today. I left government service in 1980 but my interest in aviation continues.

As director of government affairs for the Alden Electronic Co., I am still involved in aviation since my company is a prime producer of weather facsimile recorders and weather satellite ground receiving stations.

I am also a member of the American Meteorological Society Committee on Aviation Meteorology and chairman of the Weather Committee of the International Council of Aircraft Owners and Pilots Associations.

Before discussing weather information flow through the center weather service units, I would like to mention briefly three other subjects of prime importance to aviation weather and to aviation safety.

First, there is a potential for a significant decrease in the amount of weather information which would be available to both the National Weather Service and to the FAA with the increasing

emphasis on closing weather stations and with the FAA plan to phase out the majority of the flight service stations.

The FAA plan calls for installation of a large number of automatic weather stations which will provide adequate weather information for landings and takeoffs but will not provide sufficient information to the National Weather Service to prepare enroute and terminal forecasts.

The National Weather Service and the FAA must make sure that the automatic weather station provides information which is required by both agencies.

The National Weather Service would not need a full sweep of weather observations from each automatic station but some percentage of these stations should provide the National Weather Service information for input to its enroute and terminal forecasts.

Second, I would like to touch on weather radar, the most useful tool for providing hazardous weather information.

I applaud the plans of the FAA to provide color weather radar in the FAA traffic control center. But what I would like to discuss briefly here is the value which I place on the next generation of weather radars, Nexrad. Doppler radar will not solve all of the problems of hazardous weather but Doppler will provide a new level of hazardous weather information of significant importance to aviation.

We should make every attempt to insure that this project does not slip and that it's potential for improving aviation safety will be realized as soon as possible.

Third, I would like to make a strong recommendation for the highest level of coordination between the FAA and NOAA.

When I left NOAA as assistant for Aviation Affairs, I was at a level both in NOAA and the FAA where I dealt with the administrators of both agencies, with their top staff people, with the Director of the National Weather Service and his top staff, with all of the commercial and general aviation organizations and the Chairman of the National Transportation Safety Board.

The position was never filled upon my departure and I think that was a serious mistake.

Turning to the main topic of my statement, weather information flow through the center weather service units [CWSU], I won't go into the CWSU history except to say that after a period of tests at Kansas City in 1976, which proved the effectiveness of the meteorologists, it was agreed to put meteorologists first in only those centers where a preponderance of hazardous weather existed.

Later experience proved that meteorologists should be placed in all of the centers.

The intent was to provide a higher level of aviation weather support to pilots as well as to controllers. The system has never been staffed or equipped to a point where it can provide the support intended, not only for the pilots but for the towers, the Tracons, and the flight service stations, especially the en route flight advisory service.

In some centers today there is no way for the meteorologist to provide the information which is available to him to anyone in the aviation system who is outside the center except perhaps by personal telephone call.

In the beginning, we proposed that the meteorologist provide his estimate of the hazardous weather information to all of the aviation facilities within the area of responsibility of the center, including the towers, the Tracons, and the flight service stations.

In the beginning, we proposed that the center weather service Unit meteorologist provide a taped estimate of the hazardous weather occurring within his center responsibility, updated as necessary and broadcast on special frequencies which could be tuned in by the pilot in flight.

An FAA study determined that this could be done with four additional frequencies at a cost of approximately $1 million. The study was never implemented.

The impact of aviation weather on aviation safety frequently involves phenomena which are mesoscale in nature, primarily and most often the convective storm. No one is in a better position than the center weather service unit to provide the near real-time status of these phenomena to the controller and through him to the pilot.

Today, the convective sigmet is issued by the National Severe Storm Forecast center. The center meteorologist is not authorized to amend the sigmet.

Earlier there was discussion concerning transfer of convective sigmet authority to the CWSU. The CWSU is staffed only for 16 hours a day operation and the convective sigmet is potentially too vital a hazardous weather warning to operate under divided responsibility.

Mr. Chairman, my purpose in this statement is not to be critical of FAA or NOAA. Most of my career has been spent in Government service. I understand the pressures and priorities that guide the budgetary decisionmaking process and I understand the frustrations experienced by Government personnel who are dedicated to doing the best job they can with the resources at hand.

The FAA has a plan for upgrading the weather service provided by the CWSU. However, I believe there are some differences between FAA and NWS personnel concerning the manner in which this service should be provided.

Amendments to the convective sigmets and the provision of nowcasts the zero to 30-minute forecast, are two differences of opinion that come to mind. The concept of the CWSU has not yet matured. However, it has been in operation long enough for the NWS and FAA together to update, refine, and fully implement that concept.

FAA must insure that operation is consistent throughout the FAA organization. Center weather advisories should not be held within the confines of some centers while they get a wider distribution to the aviation community from other centers.

The center weather advisory should be transmitted by hot line to towers, Tracons, FSS's and where feasible to airline operations offices and general aviation activities.

The NWS must continue to provide the en route and terminal weather forecasts.

When the center weather service unit is equipped with radar display of all the hazardous weather in the center area of responsibility, it will have the best available real time hazardous aviation weather information in the system.

A realistic procedure must be initiated to facilitate input of the CWSU information into the NWS aviation weather forecast and sigmet amendment system.

Radar weather information in the center is of prime importance to the meteorologist. He is the one with the total weather picture, thus, most qualified to integrate all of the information concerning the hazard of a particular situation.

The air traffic controller, on the other hand, is the only one in the Government system who can communicate directly with the pilot in flight under air traffic control but he must not be burdened with the real time evaluation of the weather hazard.

Finally, the FAA should reopen the question of continuous broadcast of hazardous weather information directly from the center weather service unit.

I hope that decisionmakers in both the executive and legislative branches will continue to appreciate the ever-increasing importance of aviation weather information to aviation safety.

The National Transportation Board has been making this point over and over again throughout a number of administrations.

The Board has been acutely aware of the impact of weather on aviation safety and, indeed, it has the statistics to prove it.

The original concept of the center weather service unit was that it should play the primary role in providing real time weather to the pilot. To that end, the CWSU should be staffed, equipped, and provided the communications capability to fulfill that concept.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Connolly follows:]

Statement of

John W. Connolly
Director, Government Affairs
Alden Electronic Company

Mr. Chairmen, it is indeed a privilege to appear before these Subcommittees today to discuss the needs and opportunities for improvement in the distribution of weather information to pilots. During the period from approximately 1972 until 1979, when I was Assistant for Aviation Affairs to the Administrator of the National Oceanic and Atmospheric Administration, I was intimately involved in the subject under discussion in these hearings. Although I left government service in 1980, I have not lessened my interest in the provision of aviation weather information to pilots. Even in my current position as Director of Government Affairs for the Alden Electronic Company, I am still involved to some extent in Aviation Affairs, since my company is a prime producer of weather facsimile recorders and weather satellite ground receiving stations. I am also a member of the American Meteorological Society Committee on Aviation Meteorology and Chairman of the Weather Committee of the International Council of Aircraft Owners and Pilots Associations.

You have asked me to address the subject of weather information flow through the Center Weather Service Units (CWSU), and most of my statement today will be directed towards that subject. However, before discussing the CWSUs I would like to touch on several other subjects which I think are of prime importance to aviation weather and to aviation safety. First, I would like to remind the committee that there is a potential for a significant

lessening in the amount of aviation weather information which will be available to both the National Weather Service and to the Federal Aviation Administration with the increasing emphasis on closing weather stations and with the plan for the FAA to phase out the majority of the Flight Service Stations. Although the FAA plan does indeed call for installation of a large number of AWOS, Aviation Weather Observation Stations, and although these stations will indeed provide adequate weather information for landings and take-offs, they will not provide sufficient information to the National Weather Service to prepare adequate en-route forecasts and terminal forecasts. It seems to me that there is a joint responsibility here between the National Weather Service and the FAA to insure that whatever form the automatic weather station takes that it will, to the maximum extent, provide information which is required by both agencies. That is not to say that the National Weather Service would need a full sweep of weather observations from every general aviation airport, but it does imply that some percentage of these automatic weather stations, wherever located, should serve the dual purpose of providing adequate take-off and landing information while at the same time providing the National Weather Service useful information for input to its en-route and terminal forecasts.

Another subject I would like to touch on briefly is that of weather radar. It has long been my opinion that the most useful tool for providing hazardous weather information to the pilot

is weather radar. In that respect I applaud the plans of the FAA to provide color weather radar information in the air traffic control centers. However, as I will touch on later in my discussions of the Center Weather Service Units, I believe that those weather radar displays are of much more value to the CWSU meteorologist than they are to the air traffic controller. But, that is another subject, and what I would like to discuss briefly here is the value which I place on the Next Generation of Weather Radars (NEXRAD). While I do not believe that Doppler radar will solve all of the problems of the impact of hazardous weather on aviation safety, I am convinced that Doppler weather radar will provide a level of hazardous weather information of significant importance to aviation. I would urge the Committees of the Congress to consider very carefully the support which must be provided to the NEXRAD project. We should make every attempt to insure that this project does not slip so that its potential for improving aviation safety will be realized as soon as possible.

Finally, before touching on the Center Weather Service Units, I would like to make as strong a recommendation as I can for the highest level of coordination between the Federal Aviation Administration and the National Weather Service with regard to aviation weather and its impact on aviation safety. When I left the National Oceanic and Atmospheric Administration as Assistant for Aviation Affairs in 1979, I was at a position in NOAA and in

the FAA where I dealt with the Administrators of both agencies, with their top staff people, and with the Director of the National Weather Service and his top staff and with all of the commercial and general aviation organizations. I don't believe that the same level of coordination exists today. The position was never filled upon my departure, and I think that was a serious mistake. I believe that top level coordination is essential if we are going to have appropriate support for the aviation weather system.

With those few comments as introduction, I would like now to turn to the main topic of my statement here today, weather information flow through the Center Weather Service Units. The concept of placing meteorologists in the Air Traffic Control Centers was proposed some years ago by the then Commander of the Air Force Military Airlift Command. The then Administrator of the FAA and the Director of the National Weather Service met and discussed the value of placing meteorologists in the ARTCCs to provide a higher level of aviation weather information to both the Air Traffic Controllers and the pilots. As you know, after a period of tests at Kansas City, which proved the effectiveness of meteorologists in the ARTCC, it was agreed that this would be done. Early on it was decided to put meteorologists only in those centers where a preponderance of hazardous weather existed. Experience that took place over a period of a year or so proved that the

meteorologists should be placed in all of the centers.

I would like to stress again that the intent was to provide a higher level of aviation weather support to the pilots as well as to the controllers. To my knowledge the system has never been staffed or equipped to the point where it can indeed provide the level of support required not only by the pilots, but by the Towers, the Tracons and the Flight Service Stations. In some ARTCCs today there is no way for the CWSU meteorologist to provide the information which is available to him to anyone in the aviation system who is outside the Air Traffic Control Center, except perhaps by a personal telephone call. Those of us who were involved in the initiation of the CWSUs had indeed proposed a system whereby the meteorologists would be able to provide his estimate of the hazardous weather information, a Center Weather Advisory (CWA), to all of the aviation facilities within the area of responsibility of that center. The CWSU meteorologist would not only advise the controllers in the Air Traffic Control Center, but also those in the Towers and Tracons and the Flight Service Specialists as well.

In the early stages of the CWSU operation, we also discussed the possibility of the CWSU meteorologist providing a taped estimate of the hazardous weather occurring within his center of responsibility which would be updated as necessary and broadcast on special frequencies which could be tuned in by the pilot in flight. The FAA conducted a study and determined that this

could be done with four additional frequencies at a cost of approximately $1 million. The implementation of the study was never carried through. Yet, it seems to me that even today and perhaps today more than when the study was done several years ago, the need for such a timely broadcast of hazardous weather to the pilots in flight is more urgent.

When we talk about the impact of aviation weather on aviation safety, we are talking about phenomena which are mesoscale in nature, that is, we are talking primarily or most often about the convective storm. No one is in a better position than the CWSU to provide the near real-time status of these phenomena to the controller and through him to the pilot.

Currently, the Convective SIGMET, the hazardous warning of serious convective activity, is issued by the National Severe Storms Forecast Center in Kansas City. The CWSU meteorologist is not authorized to amend the SIGMET. So, while he can see that the SIGMET should be amended for the area covered by his ARTCC, he is not authorized to do so. For a long period there was discussion concerning transfer of Convective SIGMET authority to the CWSU. But, the CWSU is staffed only for 16 hours a day operation. Who would have responsibility for the other eight hours? The Convective SIGMET is potentially too vital a hazardous weather warning to operate under divided responsibility. At the same time, one should realize that the CWSU meteorologist is most often well aware of deteriorating or accelerating convective storms before an amended

SIGMET reaches him from Kansas City.

But, my purpose in this statement is not to be critical of the FAA or NOAA. Most of my career has been spent in government service. I understand the pressures and priorities that guide the budgetary decision making process. And, I understand the frustrations experienced by government personnel who are dedicated to doing the best job they can with the resources at hand.

I am aware that the FAA has a plan for upgrading the weather service provided by the CWSU. At the same time I am aware of some differences between FAA and NWS personnel concerning the manner in which this service should be provided. Such functions as amendments to the Convective SIGMETs and the provision of NOWCASTs, 0-30 minute forecasts, by the CWSU meteorologists are two differences of opinion that come to mind.

The concept of the Center Weather Service Unit has not yet matured. However, it has been in operation long enough for the NWS and FAA together to update and redefine that concept. The responsibilities of the two agencies should be set down in clear cut language so that there can no longer be differences of opinion concerning responsibilities.

The FAA must insure that whatever the concept of operation is, that it be consistent throughout the FAA organization. Center Weather Advisories (CWA), for example, should not be held within

the confines of some centers while they get a wider distribution to the aviation community from other centers. Any knowledge of hazardous weather, potentially dangerous to any segment of aviation, should get the widest distribution possible. The CWA must be transmitted to Towers, Tracons, FSSs and where feasible to airline operations offices and general aviation activities. Hotline type communications are necessary between the CWSU and all of the aviation community impacted by hazardous weather.

The NWS must continue to provide the en-route and terminal weather forecasts. But, a procedure should be adopted to allow for amendment of those forecasts based on real-time information available to the CWSU meteorologists. When the CWSU is equipped with radar display of all the hazardous weather in the center area of responsibility, it will have the best available real-time hazardous aviation weather information in the system. A realistic procedure must be initiated to facilitate input of the CWSU near real-time information into the NWS aviation weather forecast amendment system.

Radar weather information in the center is of prime interest and importance to the CWSU meteorologist. He is the one with the total weather picture, and the one, by virtue of training and experience, most qualified to integrate all of the information concerning the hazard of a particular situation.

The Air Traffic Controller is the only one in the government system who can communicate directly with the pilot in flight. But, he must not be burdened with the real-time evaluation of the weather hazard. This should be a function of the meteorologist in the center. The center weather service forecaster must be the NOWCASTER (0 to 30 minutes).

If the day arrives that the controller's scope (PVD) can show all of the hazardous weather and can differentiate the severity of all convective cells, then I might want to reconsider the relative roles of the controller and the meteorologist in the center.

Finally, I want to recommend again that the FAA reopen its earlier look into the feasibility of continuous broadcast of hazardous weather information directly from the CWSU. It seems intrinsically logical to me that such a broadcast should originate with the unit that has the most up-to-date information on the hazardous weather condition.

If I can leave the Subcommittees one thought today, it would be that decision makers in both the executive and legislative branches must continue to appreciate the ever increasing importance of aviation weather information to aviation safety. We are aware that the National Transportation Safety Board has been making this point over and over again through a number of administrations. The

board has been acutely aware of the impact of weather on aviation safety, and indeed it has the statistics to prove it.

Aviation is the major mode of commercial travel in the United States, and aviation weather plays a vital part in fatal aviation accidents. The original concept of the CWSU was that it should play the primary role in providing near real-time weather to the pilot. To that end the CWSUs should be staffed, equipped, and provided the communications capability to fulfill that concept.

Thank you.

Mr. GORE. That was great testimony. Thank you.

Mr. Dunn.

Mr. DUNN. I have no questions.

Mr. GORE. I really appreciated your statement. That gives us a good working list of things, many of which I believe we can include in our recommendations after we review what you have said and check it out against what the other witnesses have to say.

How can we immediately improve the flow of real-time weather data to both the controllers and the pilots?

Mr. CONNOLLY. I think that the provision of a communications capability to the center weather service unit meteorologist so that he can communicate directly with the watch supervisors in the Center and with the Tracons, the towers and the FSS's is the first step to take.

This was in the original plan for the center weather service units. It is in the plan for upgrading the center weather service units that Mr. Fenello talked about this morning but it has not yet been implemented and it seems to me that it is the kind of action that could be taken without significant R&D projects.

Mr. GORE. Yes; so you would agree with my statement earlier that maybe we shouldn't wait on a hardware solution to that problem. It is a matter of getting the information organized better.

Mr. CONNOLLY. It is primarily a communications problem which could be handled under today's technology.

Mr. GORE. Well, that is very interesting.

Is the problem of getting pertinent and timely weather data to the flight service station as serious or more serious than the terminal problem?

Mr. CONNOLLY. Of course, the problems are different. I would say that the terminal situation should take precedence over getting information to the flight service stations because the terminals are where we generally have the accidents.

Mr. GORE. Now, you have this proposal for the CWSU meteorologist to broadcast special pilot information beyond his responsibilities to feed data to the controllers.

Could you amplify that a little bit?

Mr. CONNOLLY. Some years ago when I was still with the Government, we ran a study with the FAA to determine the feasibility of doing just that. In addition to transcribed weather broadcasts which originate from the flight service station, it was our recommendation that since the center weather service unit had the best available real-time weather information that it would be a simple matter for him to make a tape, periodically update it as the weather situation demanded, and it would be automatically broadcast.

This was going to take four separate frequencies and as I mentioned in my statement, $1 million, because there would be the need to buy and install some new transmitters.

However, that project never came to light.

Mr. GORE. Well, let me ask you about the onboard Doppler radar. Do we have, in your opinion, the technical tools to provide this, to supplement the flow of weather information?

Mr. CONNOLLY. Well, I am not a radar expert. I do know that we have the technical tools to provide onboard Doppler radar but I am not really sure that that is the ultimate solution.

I think as one of the ALPA people mentioned this morning, while that would provide the pilot some near real-time information of hazardous weather, it may not help him significantly on takeoff.

Mr. GORE. Would you give radar display weather data to the controller's scope leaving the interpretation of that information to the controller?

Mr. CONNOLLY. No, sir.

Mr. GORE. You would have a meteorologist there?

Mr. CONNOLLY. I do see the day coming when the air traffic controller's scope would provide him a much improved display of weather information but until it can provide him all of the convective activity in the center, and can categorize it and give the kinds of information that was shown on this Doppler radar presentation, I think we are still going to need the meteorologist to do the evaluation.

Mr. GORE. Now, you left NOAA in 1979; right?

Mr. CONNOLLY. Yes.

Mr. GORE. Late 1979 or when was that?

Mr. CONNOLLY. Late 1979; yes.

Mr. GORE. And at the time you were principally responsible for coordinating weather problems and weather data with the FAA; is that right?

Mr. CONNOLLY. Yes, at the staff level and the policy level.

Mr. GORE. And yet, when you left, your position was never filled.

Mr. CONNOLLY. No, Mr. Chairman. Such a position remained in the telephone directory of the FAA for a couple of years and they finally dropped it since nobody ever showed up.

Mr. GORE. That is incredible.

Well, there is no senior official at FAA entirely responsible for this coordinating function. If there is not one at NOAA and there is no single individual at FAA, then there is no wonder there is not much coordination.

Mr. CONNOLLY. The National Weather Service has a liaison office to the FAA.

Mr. GORE. Handling all matters?

Mr. CONNOLLY. Whatever matters come before them.

Mr. GORE. But not responsible for a liaison just on weather?

Mr. CONNOLLY. No, well, he handles liaison and weather problems but that position is not at a level within either agency where it can provide policy level guidance to the administrators of those agencies.

It is actually at a working level of coordination and not at the policy level. And to my knowledge, there is no one today on the FAA staff who has an overall weather coordinating responsibility.

Mr. GORE. Well, that is really very interesting.

Let me say again, I found your testimony extremely valuable.

Let me ask you one more thing. You talk about the FAA plan to close weather stations and to phase out the majority of the flight service stations. You think that is a mistake, right?

Mr. CONNOLLY. No, not really. The point I was trying to make is that as the economy requires the closing of National Weather Service weather stations, we obviously lose weather observations there.

As the FAA plan calls for phasing out the bulk of the flight service stations of which there are over 300, we will lose weather observations there.

Now, the FAA plan calls for putting automatic weather stations in where there used to be flight service stations. But those automatic weather stations are intended to provide the information required for pilots for takeoff and landing. For example, they do not require cloud heights above 5,000 feet and as a pilot myself, that suits me fine. They don't require indication of current weather and as a pilot, that would suit me fine, too.

But from the National Weather Service point of view, to provide terminal and en route forecasts, they do need this additional weather information.

So that although these automatic weather stations will provide a critical need where we don't have observations at airports, they won't provide all of the information to the National Weather Service.

Mr. GORE. Again, that is a problem of a lack of coordination between FAA and NOAA, it would seem to me, if NOAA hadn't made that clear during the consideration of the plan.

Maybe they did but that will hurt their ability to prepare the en route forecast and the terminal forecast.

Mr. CONNOLLY. Yes, Mr. Chairman.

Mr. DUNN. Would you yield for one moment?

Mr. GORE. Sure.

Mr. DUNN. We spent some time here being critical of FAA and their communication flows.

You represent a company called Alden Electronics, I believe. When talking about problems of communication, the chairman asked you, whether it is a technological problem or a communications problem and whether the equipment is available.

You said you had no expertise in radar and yet you represent Alden Electronics. According to your testimony, this company is a prime producer of weather recorders.

If your company doesn't have the expertise and can't answer a question on whether the technology is available, where would you suggest the committee go to get that answer?

Mr. CONNOLLY. Mr. Dunn, there is a little confusion here. My response was that the technology does exist. The technology for providing the kinds of communications that are needed by the center weather service unit meteorologist exists.

Mr. DUNN. But that isn't the testimony that we are getting. Doppler radar does exist?

Mr. CONNOLLY. I am sorry, if you are talking about Doppler radar I agree that the Doppler radar doesn't exist. That is to say, there is no Doppler radar that exists today that you can go out and buy and start installing.

Mr. DUNN. So we do have a problem with the communications. We have a technology problem.

Mr. CONNOLLY. We have a technology problem as far as radar is concerned. We do not have a technology problem, in my estimation, as far as communications inside the center and from the center to the towers and the Tracons is concerned.

Mr. DUNN. We could go back with the testimony but I think that is a different answer than you gave before.

Mr. CONNOLLY. One of the questions that was asked had to do with communications of the information that is available to the center weather service meteorologist.

I said there is no technology problem that I am aware of that would stop the meteorologist from getting his information out to the towers, the Tracons, the flight service and the airlines operations office.

Mr. DUNN. But you would agree that as long as we don't have Doppler radar which can detect the velocities of wind, and that the type of equipment that we have available can only detect the amount of precipitation in any given cloud, then no matter how good the communication is the pilot is not going to have access to the complete information?

It is not technologically possible today to know the complete environment in that cloud.

Mr. CONNOLLY. That is right. You can't know the complete environment in that cloud.

Mr. DUNN. So even if we improve communication by 100 percent we are still going to have problems?

Mr. CONNOLLY. You will still have problems, yes.

Mr. GORE. But, if we improve communication we might have fewer problems.

Mr. CONNOLLY. I agree with that statement, too, Mr. Chairman.

Mr. GORE. Thank you.

Mr. Glickman.

Mr. GLICKMAN. I don't have any questions. I apologize for missing your statement. I am told that you had an excellent statement and I am also told that you were the last person to serve in a liaison role; is that correct, between the National Weather Service and FAA?

Mr. CONNOLLY. At the policy level, Mr. Chairman.

Mr. GLICKMAN. And that position no longer is filled.

Mr. CONNOLLY. I imagine it no longer exists.

Mr. GLICKMAN. Which I think is a tragedy and I hope it can be rectified.

Mr. CONNOLLY. I agree with that statement, Mr. Chairman.

Mr. GORE. Well, let me thank you again, very much, for excellent testimony and for responses to our questions. Thank you.

Mr. CONNOLLY. Thank you, Mr. Chairman.

Mr. GORE. Our next witness is Mr. Paul W. Kadlec who is an airline meteorology manager. Mr. Kadlec is also a former airline flight research meteorologist and a Brigadier General in the Air Force Reserve and now a Mobilization Assistant to the Commander of the Air Weather Service with the Military Airlift Command.

We are delighted to have you here. We appreciate your presence and without objection, your prepared statement will go in the record in full.

If you could summarize portions of it we would appreciate that. I invite you at this point to proceed.

STATEMENT OF PAUL W. KADLEC, AIRLINE METEOROLOGY MANAGER

Mr. KADLEC. Thank you, Mr. Chairman and members of the subcommittee, I appreciate the opportunity to appear before you.

As you can see, I have no staff with me. However, I represent the airline meteorologists and dispatchers who are working 24 hours a day, 365 days a year to support airline flight operations. For the record, I would like to recognize their significant contributions to improving flying safety and operational efficiency.

Many people ask why an airline has its own meteorology department, especially since the former U.S. Weather Bureau and now the National Weather Service provide weather observations and prepare forecasts for the aviation industry. Years ago, in the mid 1930's, the first meteorology and dispatch departments were formed to provide a customized or tailormade service to respond to each airlines' particular operational requirements. That is still true today as meteorologists continue to work with the dispatcher, who is really the focal point in collecting all operational information that is relayed to the pilot to advise and assist him in making timely decisions on the safe operation of the flight.

In the forties and fifties, most of the so-called trunk airlines had rather small meteorology departments that gradually evolved into fairly large staffs of between 55 and 65 people at some airlines. Those meteorology department staffs did a lot of things to provide that customized service including the preparation of high altitude wind and turbulence, enroute weather and terminal forecasts. I would also like to point out that in the fifties and sixties, much of the operational weather research in terminal forecasting including fog and low ceilings, movement of major storm systems and clear air turbulence was initiated by some of the larger airline meteorology departments. In contrast, the National Weather Service is responsible for providing weather observations, various types of forecasts and research for a wide spectrum of the general public such as farmers, firefighters, general and business aviation, airlines, radio and TV, fishing industries, and so forth.

The airlines have also been very concerned and worked with the FAA and the National Weather Service in the development and installation of the low-level wind-shear alert systems at many of our Nation's airports. At the present time, over one-half of the pro-

gramed 100-plus systems have been installed and are now operational. Although they are not the ultimate system, they are a major step forward in providing a much more objective measurement of varying wind conditions at and near an airport. The wind shear alert systems we now have at over 50 airports around the United States are certainly much better than the single wind-measuring systems we relied on before the first really serious airline wind shear accidents in the mid-1970's. However, we want to make sure that technological developments translate into more advanced systems that are responsive to the air space system as well as the entire aviation industry.

Mr. DUNN. Could I interrupt for one question?

Mr. GORE. Sure.

Mr. DUNN. You mentioned about the first wind shear accidents in the midseventies. Is that really true or the first time in the midseventies that we could attribute accidents to wind shear because our knowledge had increased?

Mr. KADLEC. I think that you are right. Low-level wind shear was first identified as a major factor if not the probable cause of some air carrier accidents during that time period when weather was involved during takeoff or landing operations. Before then, other reasons were often given for the probable cause, which may not have been completely accurate, but well within the state of our knowledge at that time of the effects of low-level wind shear on a jet aircraft.

Mr. GORE. Go ahead.

Mr. KADLEC. I would now like to read from my prepared statement.

As a result of the singularly important interest in flying safety followed by a concern for passenger comfort and operating efficiency, airline dispatchers and meteorologists are vitally interested in the advancement of aeronautical research to improve existing weather and operating deficiencies.

Although a rather significant number of programs to solve or at least minimize some of these problems have been initiated, a national resolve and commitment to support their development in conjunction with the airline and aerospace industries is absolutely essential.

I would like to briefly discuss some of the major programs and initiatives and respectfully submit them for your consideration and support:

In April 1982, the Federal Aviation Administration instituted a national airspace review program to study airspace use and procedural aspects of the air traffic control (ATC) system.

Task groups were created to address specific problem areas. Task Group 1-4 weather programs investigated the accurate and timely dissemination of real-time aviation weather information.

The opening statement of Task Group 1-4 "recommends that the FAA Administrator designate a position at the highest staff level to manage and coordinate aviation weather services."

The task group further stated that "many programs under development at this time must be coordinated to assure that they are interrelated and not competing in use of NAVAIDS."

In addition, the task group listed 25 other recommendations to the Federal Aviation Administration and the National Weather Service to improve aviation weather services. This major effort to identify and resolve these issues is highly commendable.

For the past 5 years, the National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, and the Federal Aviation Administration have sponsored an annual workshop on meteorological and environmental inputs to aviation systems and hosted by the University of Tennessee Space Institute.

The purpose of these workshops is twofold: First, to bring together various disciplines of the aviation community with meteorologists and atmospheric scientists in interactive discussions in an effort to establish and identify all the weather needs of the community and how these needs might be satisfied; and second, to use these needs to develop recommendations that then serve as a basis to structure the relevant programs of sponsoring agencies in order to enhance aviation safety and efficiency.

Attendees represented both the Government and private sectors which included airlines, associations, foreign weather services, industries, university, research and private consultants.

The fifth annual workshop from March 31 to April 2, 1981, produced 66 recommendations concerning "accuracy of forecasts, training of aviation community personnel in meteorology and the development of new equipment and/or systems that make aeronautical operations safer and more efficient."

These recommendations also included:

Programing and design of advanced simulators, operating procedures in hazardous weather, the design of future aircraft and the design and operational procedures of the Air Traffic Control system.

Arranged by major topics, recommendations were submitted relative to: winds, wind shear and turbulence; icing and frost; lightning and atmospheric electricity; fog, visibility and ceilings; ozone and other meteorological and environmental parameters; and non-meteorological factors.

These workshops and the FAA-sponsored national airspace review program have done excellent and comprehensive work in identifying aviation weather requirements to improve safety and efficiency in flight operations.

I am sure this subcommittee would find them to be most informative and useful in considering the needs and opportunities for improving the distribution of real-time weather information to pilots.

The National Oceanic and Atmospheric Administration's top priority development program is the Prototype Regional Observing and Forecasting Service [PROFS]. The program focuses initially on local or terminal area hazardous weather acquisition and forecasting problems.

Utilizing the latest technologies in weather radar, automated terminal weather observations, low level airport wind profiles, weather satellite inputs and man-machine interactive display systems, PROFS takes rapid and continuous weather observations in the Denver (Stapleton Airport) area, prepares precise short range forecasts of hazardous weather for the local airport area and disseminates this information in a format directly applicable to user operations.

At present, real-time hazardous weather data are transmitted to the Denver Air Route Traffic Control Center and airport forecast office.

Twenty-one surface observation stations, three weather radars, and a vertical wind profiler survey the area continuously to provide information directly to the user within 5 minutes of detection of the potential hazard. PROFS focuses on the most critical aviation weather problem, airport area flying safety and costly air traffic delays.

Several enhancements are already being proposed to expand this effort into a joint NOAA/NASA/FAA program for future development.

PROFS has great potential for resolving many deficiencies in the present observing and forecasting system.

Transmitting reports of rapidly changing weather conditions to an aircraft in flight, but especially in the takeoff and landing phases, has always been a concern of the meteorologist/dispatcher and ATC controller.

Unfortunately, relaying of weather data by the controller from various airport sensors that may not be entirely representative of the local environment is generally too time consuming when significant and rapid changes in weather conditions occur.

For example, thunderstorm turbulence, low-level wind shear, gusty surface winds, visibility restrictions due to rain and fog, et cetera, must be reported to the pilot in near real-time to be useful.

He can then be alerted and make preparations to cope with and avoid or at least minimize the effects of these potential hazards, especially when the aircraft is in the immediate approach or departure area of the airport.

It is imperative that efficient methods be developed to automatically transmit the output of airport ground-based weather sensing devices directly to the aircraft with a continuous readout capability in the cockpit.

These real-time data can then be supplemented with verbal communications between the controller and possibly the dispatcher/meteorologist, if necessary.

The FAA is presently testing a new device called the discrete address beacon system [DABS] that will provide rapid, nonvoice communications between the air route traffic control center and the aircraft.

DABS will transmit via data link radio communications, routine and high priority messages, including hazardous weather advisories, pilot reports and destination weather.

However, to make DABS or a similar system more efficient, ground-based weather sensors must be developed with the capability of transmitting their outputs directly to the cockpit via data link communications sytems.

The majority of U.S. airlines retrofitted their current fleet of aircraft with airborne digital weather radar systems to improve detection capabilities and reliability.

However, important advancements in radar technology have resulted in the current development of a new ground-based radar that utilizes the Doppler technique to detect and map wind or air-

flow movement as well as precipitation reflectivity in a thunderstorm.

Consequently, the Doppler radar is able to detect damaging winds and/or tornadoes produced by severe thunderstorms.

As the next logical sequence in the utilization of this technology, research is already under way to develop an airborne Doppler weather radar.

Until the airborne Doppler radar becomes reality, it is recommended that the next generation Doppler weather radar [Nexrad] currently under joint development by the NOAA National Weather Service, USAF—Air Force Geophysics Laboratory and Air Weather Service—and FAA include the capability of transmitting ground-based radar information by data link communications to the aircraft in-flight.

Since it is the intent of Nexrad to establish a U.S. network of Doppler radars, an aircraft could receive practically instantaneous radar data in the cockpit to assist the pilot in avoiding hazardous thunderstorms, wind shear and tornadoes especially, that present radar systems cannot detect with sufficient accuracy.

Mr. GORE. Let me stop you there since that is a logical breakpoint in your statement.

We have a significant vote on the floor and we will recess for approximately 10 minutes and we will pick it up where you left off.

Mr. KADLEC. Fine.

[Recess.]

Mr. GORE. The subcommittee will come back to order. Please proceed.

Mr. KADLEC. Thank you.

In the 1960's, the airline industry expressed considerable interest in the development of an airborne clear air turbulence detection system.

Early efforts identified possible atmospheric conditions that were not only necessary for the formation and existence of clear air turbulence [CAT], but that were also detectable with aircraft sensors.

For an airborne CAT detection system to be useful, it must be able to, first, detect and warn of the imminent presence of CAT; second, indicate the intensity of the turbulence and; third, provide information on how to avoid or at least minimize its effect on the aircraft by either reducing air speed, changing altitude and/or making a lateral deviation in aircraft routing.

Warning times may vary, but in general, flight crews require a minimum of 3 minutes, but preferably 5 minutes warning before encountering significant turbulence of moderate or greater intensity.

Research to develop an airborne detection system began in the mid to late 1960's and continued through the 1970's. A rather small amount of research is currently devoted to flight testing two types of radiometers to determine their effectiveness in detecting clear air turbulence.

An infrared and microwave radiometer have been developed independently by research scientists of the NOAA Environmental Research Laboratories and the Jet Propulsion Laboratory.

Both systems have been flown for several years primarily on aircraft of the NASA Ames Flight Research Center in San Jose, Calif.

Flight tests of the infrared system have also included evaluation of the sensor's ability to detect low level wind shear as well as high altitude clear air turbulence.

The microwave system has concentrated on detecting high altitude CAT and providing avoidance information. Results of both programs are encouraging but much remains to be done before a fully operational system is finally developed.

Although the incidence of serious encounters of CAT is small, injuries to passengers and cabin attendants especially, still occur as evidenced by the recent CAT incident over the Rocky Mountains.

Since the initial research was done by Eastern Airlines under Government sponsorship, the remainder of the development work must also logically be continued by research scientists with Government support.

If a practical system can be developed and flight tested, then the follow-on operational test and evaluation should be conducted in a joint Government/military/airline industry effort.

In conclusion, I have concentrated my discussion of the distribution of weather information to pilots in three primary areas. They are first, managing and coordinating research and development and implementation of aviation weather services; second, establishing the requirement for automatic and reliable transmission of operationally important real-time weather and flight information to the pilot from airport ground sensors with the capability for additional voice communications between the ATC controller, dispatcher, or meteorologist; and third, recommendations for continuing research and development of onboard sensors and detection systems to provide the pilot with instantaneous and continuous information on operationally significant weather conditions to assist him in avoiding potentially hazardous weather conditions during the operation of the flight.

[The prepared statement of Mr. Kadlec follows:]

WEATHER INFORMATION DISSEMINATION TO AIRLINE FLIGHT OPERATIONS

Paul W. Kadlec[1]

Providing accurate and timely weather observations and forecasts to airline flight crews has historically been a primary concern of aeronautical meteorologists and flight dispatchers. With the formation of the first airline meteorological and dispatch services in the mid-1930's came the recognition of the growing importance of providing customized weather information to improve safety and operational efficiency. In the 1950's and 60's, airline meteorology departments of most of the so-called "trunk lines" expanded significantly to provide extensive weather services tailor-made to each airline's particular operational requirements. Also during this period, the flight dispatch and communications departments of all the U.S. airlines developed improved procedures to transmit weather information to the pilot inflight as well as on the ground. Company radio operators relayed significant weather and other operational information to and from the pilot, but company teletype networks distributed the majority of weather and operational data

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[1]Testimony presented on August 11, 1982 before the Subcommittees on Transportation, Aviation and Materials, and Investigation and Oversight, Committee on Science and Technology, U.S. House of Representatives. Mr. Kadlec is an aeronautical meteorologist, former Flight Research Meteorologist, Eastern Airlines and Manager - Meteorology, Continental Airlines. He is a Brigadier General, U.S. Air Force Reserve, presently serving as the Mobilization Assistant to the Commander, Air Weather Service, Military Airlift Command.

to each station served by the airline. In addition, all airlines utilized surface and upper-air weather observations provided by the former U.S. Weather Bureau and many used these data to prepare their own aviation forecasts.

As a matter of interest, the U.S. Air Force and Navy have the largest force of experienced aviation meteorologists in the U.S. Although some military bases do not have forecasters on duty 24 hours a day due to required reductions in service, a military pilot can initiate a call on the military Ultra High Frequency radio weather channel and discuss enroute weather and weather conditions at the base of departure or intended landing. This Pilot-to-Metro-Service (PMSV) has been in operation since 1952 to aid and advise pilots on the latest weather reports, real-time weather radar observations and short range forecasts.

In the late 1950's, the U.S. Weather Bureau, followed by the National Weather Service, developed the capability of transmitting weather charts prepared at their national weather center, over telephone lines utilizing a facsimile transmitting and recording system. As the quality of the transmitted charts improved, airline meteorology and dispatch departments relied more extensively on the "fax charts" for use in forecasting as well as flight crew and dispatcher briefings. With the centralization of most dispatch and meteorology offices in the 1970's came a gradual reduction in airline weather department staffs. Therefore, the use of weather facsimile charts became even more important for pilot self-briefing to complement weather observations, reports and forecasts received on the teletype network. Going one step farther, some airlines tailored the dissemination of weather charts internally, by also installing facsimile transceivers at major terminals, flight crew bases and/or lay-over

stations to transmit charts over existing telephone lines. These company operated fax networks reduced the volume of maps and provided certain additional specially prepared charts of particular interest to flight crews that could be transmitted in three minutes or less per chart.

As the airlines completed the transition from reciprocating engine powered aircraft to the jet and prop-jet, meteorology and dispatch departments developed new, rapid and more efficient methods of disseminating weather information to the pilot, both in the air and on the ground. At the same time, communications systems began to take advantage of new technology developed in support of the national space program to improve transmission speeds and response to query via computerized message distribution systems. That evolution continues today and with even greater promise for the future. For example, the airlines through their own communications company, Aeronautical Radio, Inc. (ARINC) have developed the ARINC Communications Addressing and Reporting System (ACARS) to greatly facilitate communications between the aircraft and the airline ground operations or dispatch center. ACARS utilizes an Aeronautical Radio, Inc., Very High Frequency radio network to send and receive messages to an aircraft in flight via a computerized digital data link radio transmission system. ACARS features an address capability that enables the transmission or exchange of data and messages between the dispatcher or ground control center and one particular aircraft or as many as desired, by merely including the flight number of each aircraft in the address. An airborne subsystem of ACARS also provides for manual entry by the pilot of routine flight data for either manual or automatic transmission to the ground. Also, an automatic function stores and transmits aircraft OUT-OFF-ON-IN event times to the ground operations center at specified times in accordance with the system computer memory program. In

addition, ACARS provides the capability to open a voice channel for essential verbal communication between the pilot and dispatcher. As a result, it is common practice for the dispatcher to contact an aircraft in flight anywhere in the company domestic route system in one to three minutes, or even less on occasion. At the present time, ten U.S. airlines have installed ACARS on their entire operational fleet of aircraft while several others are planning to do so in the near future. The remaining U.S. domestic airlines have either developed their own company communications system or utilize ARINC's other communication facilities that provide ground-to-ground teletype and computerized communications services as well as a ground-to-air Very High Frequency radio network to transmit messages between the aircraft and ground control or dispatch centers. An additional equipment enhancement to ACARS that is in use by three airlines provides a hard copy of messages transmitted to a printer in the aircraft cockpit. Therefore, it is now possible for the pilot to receive a print-out of weather and other operational information from the dispatcher or ground control center in greater detail, without having to manually copy an orally transmitted message. Satellite communications capabilities are also under development by ARINC that will utilize computer, communications and space technology to provide rapid and reliable Very High Frequency radio transmission links between ground stations and aircraft on a world-wide basis. The primary purpose of these increasingly elaborate and sophisticated communications systems is to be able to transmit and receive operationally significant information between the dispatcher/meteorologist and pilot. Air traffic controllers and pilots also exchange weather information of particular interest to flight crews including reports of enroute turbulence, severe weather, strong winds and other significant weather conditions that could affect safety and passenger comfort. However,

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weather and other operational information is transmitted to the pilot primarily to advise and assist him in making timely decisions on the safe operation of the flight as well as concern for passenger comfort and operating efficiency. All decisions regarding the actual flying of the aircraft rest with the Captain except for directions received by the flight crew from the FAA Air Traffic Control system exercising its responsibilities to monitor and control aircraft movement on the ground and in the air. However, the Captain can still exercise his authority to override an Air Traffic Control clearance for example, when flying safety might be jeopardized or threatened.

As a result of the singularly important interest in flying safety followed by a concern for passenger comfort and operating efficiency, airline dispatchers and meteorologists are vitally interested in the advancement of aeronautical research to improve existing weather and operating deficiencies. Although a rather significant number of programs to solve or at least minimize some of these problems have been initiated, a national resolve and commitment to support their development in conjunction with the airline and aerospace industries is absolutely essential.

I would like to briefly discuss some of the major programs and initiatives and respectfully submit them for your consideration and support:

1. In April, 1982, the Federal Aviation Administration instituted a National Airspace Review Program to study airspace use and procedural aspects of the Air Traffic Control (ATC) system. Task groups were created to address specific problem areas. Task Group 1-4 Weather Programs, investigated the accurate and timely dissemination of real-time aviation weather information. The opening

statement of Task Group 1-4 "recommends that the FAA Administrator designate a position at the highest staff level to manage and coordinate aviation weather services." The Task Group further stated that "many programs under development at this time - must be coordinated to assure that they are interrelated and not competing in use of NAVAIDS." In addition, the Task Group listed twenty-five other recommendations to the Federal Aviation Administration and the National Weather Service to improve aviation weather services. This major effort to identify and resolve these issues is highly commendable.

2. For the past five years, the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA) and the Federal Aviation Administration (FAA) have sponsored an annual workshop on Meteorological and Environmental Inputs to Aviation Systems and hosted by the University of Tennessee Space Institute. The purpose of these workshops is twofold: "1) to bring together various disciplines of the aviation community with meteorologists and atmospheric scientists in interactive discussions in an effort to establish and identify all the weather needs of the community and how these needs might be satisfied; 2) to use these needs to develop recommendations that then serve as a basis to structure the relevant programs of sponsoring agencies in order to enhance aviation safety and efficiency." Attendees represented both the government and private sectors which included airlines, associations, foreign weather services, industries, university, research and private consultants. The Fifth Annual Workshop from 31 March - 2 April 1981 produced sixty-six recommendations concerning "accuracy of forecasts, training of aviation community personnel in meteorology and the development of new

equipment and/or systems that make aeronautical operations safer and more efficient." These recommendations also included: "programming and design of advanced simulators, operating procedures in hazardous weather, the design of future aircraft and the design and operational procedures of the Air Traffic Control system. Arranged by major topics, recommendations were submitted relative to: winds, wind shear and turbulence; icing and frost; lightning and atmospheric electricity; fog, visibility and ceilings; ozone and other meteorological and environmental parameters; and non-meteorological factors." These workshops and the FAA sponsored National Airspace Review Program have done excellent and comprehensive work in identifying aviation weather requirements to improve safety and efficiency in flight operations. I am sure this Subcommittee would find them to be most informative and useful in considering the needs and opportunities for improving the distribution of real-time weather information to pilots.

3. The National Oceanic and Atmospheric Administration's top priority development program is the Prototype Regional Observing and Forecasting Service (PROFS). The program focuses initially on local or terminal area hazardous weather acquisition and forecasting problems. Utilizing the latest technologies in weather radar, automated terminal weather observations, low level airport wind profiles, weather satellite inputs and man-machine interactive display systems, PROFS takes rapid and continuous weather observations in the Denver (Stapleton Airport) area, prepares precise short range forecasts of hazardous weather for the local airport area and disseminates this information in a format directly applicable to user operations. At present, real-time hazardous weather data are

transmitted to the Denver Air Route Traffic Control Center and airport forecast office. Twenty-one surface observation stations, three weather radars and a vertical wind profiler survey the area continuously to provide information directly to the user within five minutes of detection of the potential hazard. PROFS focuses on the most critical aviation weather problem, airport area flying safety and costly air traffic delays. Several enhancements are already being proposed to expand this effort into a joint NOAA/NASA/FAA program for future development. PROFS has great potential for resolving many deficiencies in the present observing and forecasting system.

4. Transmitting reports of rapidly changing weather conditions to an aircraft in-flight, but especially in the takeoff and landing phases, has always been a concern of the meteorologist/dispatcher and ATC controller. Unfortunately, relaying of weather data by the controller from various airport sensors that may not be entirely representative of the local environment is generally too time consuming when significant and rapid changes in weather conditions occur. For example, thunderstorm turbulence, low level wind shear, gusty surface winds, visibility restrictions due to rain and fog, etc., must be reported to the pilot in near real-time to be useful. He can then be alerted and make preparations to cope with and avoid or at least minimize the effects of these potential hazards, especially when the aircraft is in the immediate approach or departure area of the airport. It is imperative that efficient methods be developed to automatically transmit the output of airport ground-based weather sensing devices directly to the aircraft with a continuous readout capability in the cockpit. These real-time data can

then be supplemented with verbal communications between the controller and possibly the dispatcher/meteorologist, if necessary. The FAA is presently testing a new device called the Discrete Address Beacon System (DABS) that will provide rapid, non-voice communications between the Air Route Traffic Control Center and the aircraft. DABS will transmit via data link radio communications, routine and high priority messages including hazardous weather advisories, pilot reports and destination weather. However, to make DABS or a similar system more efficient, ground based weather sensors must be developed with the capability of transmitting their outputs directly to the cockpit via data link communications systems.

5. The majority of U.S. airlines have retrofitted their current fleet of aircraft with airborne digital weather radar systems to improve detection capabilities and reliability. However, important advancements in radar technology have resulted in the current development of a new ground based radar that utilizes the Doppler technique to detect and map wind or airflow movement as well as precipitation reflectivity in a thunderstorm. Consequently, the Doppler radar is able to detect damaging winds and/or tornadoes produced by severe thunderstorms. As the next logical sequence in the utilization of this technology, research is already under way to develop an airborne Doppler weather radar. Until the airborne Doppler radar becomes reality, it is recommended that the Next Generation Doppler Weather Radar (NEXRAD) currently under joint development by the NOAA National Weather Service, USAF (Air Force Geophysics Laboratory and Air Weather Service) and FAA include the capability of transmitting ground based radar information by data link communications to the aircraft inflight. Since it is the intent

of NEXRAD to establish a U.S. network of Doppler radars, an aircraft could receive practically instantaneous radar data in the cockpit to assist the pilot in avoiding hazardous thunderstorms, wind shear and tornadoes especially, that present radar systems cannot detect with sufficient accuracy.

6. In the 1960's, the airline industry expressed considerable interest in the development of an airborne clear air turbulence detection system. Early efforts identified possible atmospheric conditions that were not only necessary for the formation and existence of clear air turbulence (CAT), but that were also detectable with aircraft sensors. For an airborne CAT detection system to be useful, it must be able to 1) detect and warn of the imminent presence of CAT, 2) indicate the intensity of the turbulence and 3) provide information on how to avoid or at least minimize its effect on the aircraft by reducing airspeed, changing altitude and/or making a lateral deviation in aircraft routing. Warning times may vary, but in general, flight crews require a minimum of three minutes, but preferably five minutes warning before encountering significant turbulence of moderate or greater intensity. Research to develop an airborne detection system began in the mid to late 1960's and continued through the 1970's. A rather small amount of research is currently devoted to flight testing two types of radiometers to determine their effectiveness in detecting CAT. An infrared and microwave radiometer have been developed independently by research scientists of the NOAA Environmental Research Laboratories and the Jet Propulsion Laboratory. Both systems have been flown for several years primarily on aircraft of the NASA Ames Flight Research Center in San Jose, CA. Flight

tests of the infrared system have also included evaluation of the sensor's ability to detect low level wind shear as well as high altitude clear air turbulence. The microwave system has concentrated on detecting high altitude CAT and providing avoidance information. Results of both programs are encouraging but much remains to be done before a fully operational system is finally developed. Although the incidence of serious encounters of CAT is small, injuries to passengers and cabin attendants especially, still occur as evidenced by the recent CAT incident over the Rocky Mountains. Since the initial research was done by the airlines under government sponsorship, the remainder of the development work must also logically be continued by research scientists with government support. If a practical system can be developed and flight tested, then the following operational test and evaluation should be conducted in a joint government/military/airline industry effort.

In conclusion, I have concentrated my discussion of the distribution of weather information to pilots in three primary areas. They are 1) managing and coordinating research and development and implementation of aviation weather services, 2) establishing the requirement for automatic and reliable transmission of operationally important real-time weather and flight information to the pilot from airport ground sensors with the capability for additional voice communications between the ATC controller, dispatcher or meteorologist, 3) recommendations for continuing research and development of on-board sensors and detection systems to provide the pilot with instantaneous and continuous information on operationally significant weather conditions to assist him in avoiding potentially hazardous weather conditions during the operation of the flight.

I sincerely appreciate the privilege and honor to present this information to the Subcommittee.

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Mr. GORE. Thank you very much for excellent testimony.

Mr. Dunn.

Mr. DUNN. Can you fill us in. You took us through the history of company-owned weather advisories and company meteorologists. What role do they play today? Is most of the information the pilots receive from flight service and FAA, or are you still operating independently?

Mr. KADLEC. Not independently, sir, because we receive a lot of basic information such as surface and radar observations for example as well as convective sigmets, and other types of forecasts of a severe or operationally significant nature. When that information is received by the dispatcher, he quickly evaluates it and determines if it should be passed on to the pilot. If that is the case, he can then call the pilot and advise him of weather conditions that may affect the flight.

Mr. CONNOLLY. A lot of the decisions made by the dispatcher and meteorologist are important to the pilot. If there is any doubt he will do it.

Mr. DUNN. I guess the nature of my question is—is it possible for two different pilots one from TWA for example and Air Florida in the case of what happened here at National Airport, to receive two different sets of information? Both pilots go to flight service to get a briefing before departure but is it possible that two pilots on that given day had two different sets of information, and the Air Florida pilot might have made a different decision than TWA, or whatever, behind him?

Mr. KADLEC. That is difficult to answer. In weather related accidents, we are looking at information that is very perishable. For example, in the case of the takeoff or a landing wind shear accident, there is relatively little communication between an airline dispatcher at the time of takeoff or just before landing. So I would say the great majority of the time the pilot has to depend on the air traffic controller to relay timely information to him. The airline dispatcher or meteorologist can advise him perhaps 10-15 minutes ahead of time during the descent to advise that there are severe thunderstorms at the airport or in the immediate vicinity, but the chance to talk to a pilot a couple of minutes before touchdown or

just before takeoff is much more remote. Pilot communications at that time are primarily with the air traffic controller who can relay information from ground-based sensors to assist the pilot in making that go-no go decision.

Mr. DUNN. You talked about the case of the thirties where Eastern Airlines was going one direction and were providing virtually the only weather service in that part of the country where they were going, and some other airline was doing the same in another part of the country. I am just wondering if all the airlines got together and instead of funding their individual meteorologists, fund some through to the FAA, if that would be a more reliable system? Indeed, the majority of the pilots are relying on the Government for the bulk of their information anyway. Is there redundancy today that is not necessary?

Mr. KADLEC. I believe there is some. One of the problems we are facing at the present time is the increased Government control on how we fly airplanes from point A to point B within the airspace system. There is simply less flexibility because of restrictions on the use of alternate airway routings, as one example. Since meteorological staffs have for the most part, been significantly reduced in recent years, the airlines are using more and more of the National Weather Service information. So redundancy is now relatively minor.

Mr. DUNN. You make the point that you have to now because of restrictions. But I think you would also agree that you are relying more on the Government now because the FAA is doing a better job than they did 10 or 20 years ago. It is a much broader based, much more sophisticated system.

Mr. KADLEC. That is right. National Weather Service and the FAA both have improved their service to aviation. Also, new aircraft avionics and flight control systems as well as the aircraft itself together with the expanded use of highly sophisticated flight simulators to provide much more realistic pilot training have had an impact in recent years on the type and quality of weather support the airlines require. However, as the testimony by the Air Line Pilots Association indicated, some data such as ground based weather radar summaries can only be used for flight planning purposes. To help a pilot avoid severe weather in real time, we need something much better than the current type of radar summary chart. It serves a purpose, primarily for forecasting and flight planning. Fortunately, airline aircraft are equipped with weather radar. Ground-based radar information can also be provided in near real time by the air traffic controller or possibly the dispatcher using a remote radar display system.

Mr. DUNN. I thank you.

Mr. GORE. How common is the so-called downburst problem?

Mr. KADLEC. The occurrence of downbursts are hard to quantify because the only time we really hear about them is when an airplane encounters one or if there is visual confirmation by a ground observer. However, they occur in varying intensities with every severe thunderstorm. But the affect on an airplane depends on the aircrafts' flight configuration and proximity to the downburst as well as the intensity of the burst. Timing is also tremendously important. As little as 3 to 5 minutes can make an awful lot of differ-

ence in the severity of the downburst wind shear and its affect on the airplane. Wind shear has always been present, but it is extremely rare that an aircraft would fly into an area at the precise time when severe wind shear could be a major factor in causing a catastrophic accident.

Mr. GORE. Based on your experience with Continental, how would you describe their wind shear criteria for a go/no-go decision?

Mr. KADLEC. As mentioned earlier today, the 15-knot difference between various sensors around the airport and the centrally located anemometer or wind measuring system is one of the criterion used by the pilot to make a go/no-go decision. Other equally important considerations include: high surface temperatures, large temperature/dewpoint differences, large variations in the surface wind direction and speed, thunderstorms near the airport, pilot reports of significant low altitude airspeed changes and reports of low-level wind shear. After evaluating these and operational considerations, the pilot makes his decision to takeoff or land.

Mr. GORE. Are airline meteorologists satisfied with the current organization of the FAA concerning weather as a causative factor in airline problems?

Mr. KADLEC. I think we all feel that we would like to see improvement and we agree with the issues we have identified today. I certainly agree with the National Airspace Review Report. Those are the kind of recommendations that the Air Transport Association and many other organizations involved in the review feel need to be addressed. The FAA and the National Weather Service do a good job, but obviously we would like to see improvements where possible.

Mr. GORE. That is a diplomatic response, but one that is not at all difficult to interpret. How does the commercial weather information dissemination compare with the military system that you have had experience with?

Mr. KADLEC. The Air Force and Navy have a different system since each military air base has aviation forecasters on duty either 24 hours a day or at least during the time of normal flight operations. We also have a very important communications capability known as the pilot-to-metro-service [PMSV], where a pilot can talk via UHF radio directly with an aviation forecaster. With PMSV, a military pilot can obtain short range forecasts, the latest weather reports, real-time weather radar information or any other meteorological data he might require. The real-time dissemination of weather information is especially important since we are concerned with the significant variations in pilot experience level. The military weather services are vitally interested in responsing to the needs of a pilot that is flying a relatively high-performance airplane who may have less than 500 hours flying time as well as a more senior experienced pilot who has flown 10,000 hours in many types of aircraft. For this and other reasons. The Department of Defense continues to justify this level of weather support for the military services.

Mr. GORE. OK. Well, thank you again for excellent testimony and for your responses to our questions. We appreciate it very much.

Mr. KADLEC. Thank you.

Mr. GORE. Thank you.

Our final witness is Richard Hallgren, Director of the National Weather Service with the National Oceanic and Atmospheric Administration. Welcome. We appreciate your patience during this long day of hearings.

If you could identify your associates, please.

STATEMENT OF RICHARD E. HALLGREN, DIRECTOR, NATIONAL WEATHER SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE; ACCOMPANIED BY ANTHONY F. DURHAM, NEXRAD JOINT SYSTEM PROGRAM OFFICE DIRECTOR, NATIONAL WEATHER SERVICE, AND CHARLES H. SPRINKLE, CHIEF, AVIATION BRANCH, NATIONAL WEATHER SERVICE

Mr. HALLGREN. Yes, Mr. Chairman, members of the committee. I was just reflecting as to whether if I had a choice, I wished to be a first witness or a last witness. I haven't reached that conclusion.

Nevertheless, I appreciate this opportunity to assist in assessing the distribution of weather information to pilots through the air traffic control system, and to discuss the needs an opportunities for improvement in order to reduce weather-related accidents.

I have brought along two people with me. First on my left is Mr. Charles Sprinkle who is Director of Aviation Weather Service. On my right is Mr. Tony Durham who is Director of the NEXRAD national program office.

Mr. GORE. Thank you very much.

Without objection, your entire text will be put into the record in full. If you could summarize we would appreciate it.

Chairman Glickman has a bill under consideration in the full committee right now. He wanted to be here for your testimony. Of course, he is going to follow it carefully in the record.

We would invite you to proceed. Again, if you could summarize portions of it, it would be helpful.

Mr. HALLGREN. OK, I will try and cut it down some. But as one of the earlier witnesses indicated——

Mr. GORE. It has already been cut down? That is fine.

Mr. HALLGREN. The primary responsibilities of the National Weather Service of the National Oceanic and Atmospheric Administration are to provide warnings of severe weather and floods in order to protect lives and property; provide public forecasts for land and adjacent ocean areas for planning and operations; and provide weather support for the production of food and fiber, management of water resources, production, distribution, and use of energy, and efficient and safe conduct of air commerce.

One of the reasons I wanted to bring out those various areas is that whenever you are tryng to handle the situation related to a flood or to a severe weather event, you are dealing with mesoscale phenomena. That has been discussed here time and time again.

Likewise, whenever you are working in aviation forecast problems, you are very frequently dealing with mesoscale phenomena. So in our stations across the country the way we are staffed the people are working both problems on many occasions because the

essence of a good portion of that forecast is related to handling the small scale motions of the atmosphere as well as you can, and then, in turn, this serves both the preparation of a warning to the public, as well as vital information to aviation.

The principal task of the National Weather Service is to issue severe weather warnings to save lives and minimize property loss. And it turns out that the United States has a greater variety of severe weather than any other nation in the world. Hurricanes, tornadoes, floods, flash floods, thunderstorms, and severe winter weather take many lives and cause thousands of injuries every year, despite advances in technology and forecasting skills.

The Nation's losses from these extreme weather events is in the billions of dollars each year. And this does not include aviation, our most important and weather sensitive industry.

The Aviation Weather Services program is a cooperative effort as described in a formal Memorandum of Agreement between the Federal Aviation Administration of the Department of Transportation and National Weather Service of the Department of Commerce.

The National Weather Service is responsible for preparing forecasts and warnings and the Federal Aviation Administration disseminates this weather information to users. This requires the teamwork and cooperation which has become a tradition between our two agencies.

In light of the discussions that have taken place I thought I might just give you several views on how I look at it from the Weather Service.

When I took over the Weather Service in early 1979, although I had been there on prior occasions, I recognized that a very, very important relationship, if we are to be successful, is with the FAA. And, quite frankly, I wanted to see that to be in as good shape as possible.

Therefore, I decided to personally take a much more active role in that particular relationship than the previous Director, a judgment call. One of the reasons was what I asserted just a few minutes ago. Whenever you are dealing with the primary mission of the Weather Service, and that is getting warnings out to all of the users, the problems are so similar, whether it is an aviation problem or whether it is providing a good flash flood forecast, or whether it is issuing a tornado warning. Therefore, the whole activity runs across the whole of the Weather Service.

If the Director is not personally involved in these matters, it becomes very, very difficult to keep a coordinated and overall concerted effort.

A key one was with the working on the FAA relationship, so I decided to personally carry the policy aspects of that. And, therefore, over the last 3 years, I have been personally a member of the program councils for the nexrad program, and for the automation of weather observation program, in which I met very frequently with the Associate Administrator, Jim Bispo, up until his departure here just a couple weeks ago. On the nexrad program I meet frequently with the Deputy Associate Administrator, Neal Blake.

So I have been personally working on it. And I guess the only conclusion I could have is Mr. Connolly doesn't think I am doing a

very good job at it. So I shall try to do better on the coordination in the future.

But it is such a highly important area that I felt I must personally do a great deal of the coordination.

Today, the National Weather Service provides a broad range of products for the aviation community. Fifty-two National Weather Service forecast offices prepare airport terminal forecasts three times per day with amendments as needed for approximately 500 airports in the 50 States and in the Caribbean.

Our offices also produce about 300 individual route-oriented forecasts three times per day for the 48 contiguous States. Thirteen of these offices prepare area forecasts of aviation weather conditions across the entire country twice a day.

These same offices issue advisories of hazardous weather conditions for areas of turbulence, icing, strong low-level winds, and/or extensive areas of low clouds or visibility. When advisories of dangerous conditions associated with thunderstorms are warranted, they are issued each hour by an aviation unit at the National Severe Storms Forecast Center in Kansas City specifically dedicated to that task.

The question of how to disseminate weather information to briefers, controllers and users of the national airspace system in the most timely and efficient manner possible, especially during hazardous weather, is one problem. The other is detecting and forecasting the hazards which I will discuss later.

Disseminating information is accomplished essentially for two phases of flight, the preflight planning stage and the inflight hazardous weather avoidance stage.

In the preflight stage, the FAA provides about 95 percent of the pilot weather briefings and we, in the National Weather Service, provide about 5 percent.

Many pilots also view aviation weather public television shows, which are shown on about 250 stations each morning, to get a first or broad view of the weather and the expected hazards of the day.

It might be a bit presumptuous but I think we are doing at least a reasonable job in providing the forecasts for the preflight stage and supporting ongoing projects that will further assist us in acquiring, integrating, displaying, and disseminating information. They include automatic surface and upper air observations, a program I referred to a few minutes ago, where we are trying to get an automatic station that would do the full job, if possible, of taking aviation observations, as well as an observing/reporting system used in the navigation system on commercial aircraft.

There are possibilities down that line. We tested such airborne reporting systems a few years ago. We are trying to get better observations through that particular arrangement in which they all transmitted from the aircraft up to a satellite and back to the ground very quickly, or through a VHF system.

We are also working on systems for merging radar and satellite presentations. One particular effort in this regard, is the PROFS system mentioned earlier. I am deeply involved in that one as well, because it also focuses on the mesoscale.

Computer assistance in preparing short-term terminal forecasts and interactive graphic techniques to produce a user accessible nowcast/forecast data base is another effort.

But the need for further improvement has been driven home by all the speakers today. There are just too many accidents each year that are weather related. What kind of accidents? What kind of weather is hazardous? That varies. For the general aviation pilot it is low visibility and ceiling, icing, severe turbulence and thunderstorms in the en route phase that produce the majority of accidents.

However, for the commercial aviation pilot, the primary en route hazard is the thunderstorm and clear air turbulence. In the terminal area it is wind shear and ice or snow.

Let's look at the in-flight phase. It is necessary to divide this stage of flight into the en route and terminal phases. In the en route phase, actions have been taken in recent years to make the airspace safer.

One major FAA effort is their En Route Flight Advisory Service which allows the specialist to talk directly to the pilot exchanging routine weather information or providing help in avoiding a hazardous weather situation. This, of course, is carried out by FAA.

The second major effort is the Center Weather Service Unit program, a joint program between the Weather Service and FAA.

The actual situation is that the funding is provided to the Weather Service by FAA and we carry out the program. The program places, as I said, Weather Service meteorologists at 21 air route traffic control centers where they provide weather consultation and advice to air traffic managers and controllers who, in turn, relay pertinent information to pilots.

This system is designed to get essential weather information more quickly from the experts to the airborne pilots. Remote radar color monitors will be installed, beginning this fall, to provide the center weather service unit meteorologists with direct access to real-time weather radar information. This is a significant step in getting the most timely information to pilots in both en route and terminal phases of flight.

The FAA is examining and testing approaches such as broadcasting instructions and weather information directly to a screen in the cockpit and the continuous voice broadcasts of potentially hazardous weather information.

And we can discuss any of the problems that may exist in that program. It is an evolving program, one, as indicated, that was started a few years ago. Much has been done, much remains to be done to make full advantage of the overall program.

Now, let me turn to the complex problem of providing weather data in the terminal environment. We are all aware that it is here that the most critical phase of the flight occurs and we are becoming more and more aware of the rapidly varying weather factors that are significant during this phase of flight.

Since this is an extremely busy period for the pilot, the terminal weather dissemination system has to be extremely responsive to reflect changing conditions and the information has to be pertinent to the individual pilot's needs. This information currently consists of the latest available observation and may include a summarized

version of pertinent in-flight advisories. It is normally received through approach control, a tower, or an automatic terminal information service broadcast.

There are other weather phenomena beyond the commonly recognized hazards of low ceiling and/or severe thunderstorms, which, while invisible to the human eye, may represent hazards to aviation.

Some of these effects are particularly significant at the low altitudes of the terminal phases of a flight. New systems and advanced technology can help us to identify and locate some of these newly recognized hazards and to reduce their part in aircraft accidents.

Among these nonvisible hazards are the following:

Wind shear, a significant hazard to aviation especially during final approaches and takeoffs; and

Gust fronts, downbursts and the microbursts that are within that whole framework.

It is very clear to me that we have to find better ways of detecting them and get that information into the decisionmaker's hands, that is the pilot, who is either ready to take off or is in the process of landing.

To do the job right in trying to prepare the most up-to-date forecasts and most up-to-date advisories for the aviation program requires that we deal with the very short range forecast, the very small scale weather effects.

A forecast for a terminal—for terminal conditions is very much a mesoscale problem. It isn't forecasting for a county area. It is forecasting for a strip a couple miles long, and just a few hundred meters wide.

Therefore, it is a very, very fine forecast. And it is going to require us to bring all of the data together and assimilate it as quickly as possible to make the proper decisions in that regard.

We have a number of activities that are trying to bring the data together to do that. Some of these are the automatic stations, ground-based remote sensing systems, Doppler radar and the use of satellite information, together with the capabilities of the existing mini and microcomputers that now have the ability to assimilate all this information within a reasonable economic cost.

And we have all of these in various stages of development and evaluation in operational environments. And I believe we can look forward to a greatly improved data base for short-term forecasting of aviation weather hazards because of these activities.

Earlier I mentioned the ever-increasing dangers to aviation from wind shear and downbursts. Research on these phenomena has begun in the past 5 years.

We are all aware of the joint airport weather studies project. This is a very productive study being conducted out at Stapleton Airport in Denver under many agencies in a cooperative way. The principal objective of this project is to gain insights into the small scale meteorological conditions associated with thunderstorms, particularly at low levels.

The study group is testing an array of wind shear detection instrumentation in a dense automated observation network at Denver's Stapleton Airport and is using three Doppler radar systems and research aircraft and an array of surface stations. They hope

to be able to follow the entire downburst lifecycle and then compare the results with visual observations.

The ability of Doppler radar to detect thunderstorm downbursts, microbursts, and wind shear conditions has been demonstrated. There have been some exciting findings with significant implications for aviation safety. They have found downbursts and wind shear produced by innocent looking cumulus clouds as well as those imbedded in the main thunderstorm cells.

They found that downbursts last an average of only about 5 minutes and cover an area of a few miles, in fact, down to maybe a thousand meters in diameter. With regard to an earlier question you asked as to how frequently they take place. In the Stapleton area during this summer a very substantial number of the days they observed downbursts or microbursts of varying intensities and obviously for varying periods during the day. But a very substantial percentage of the days, I can't recall just offhand. Seventy or eighty percent of the days. I think that is going to be an unusual summer out there. But, they are going to be quite frequent when we see them in their full detail.

Mr. Chairman, I have, during the course of my testimony, made several references to the use of Doppler radar in the detection of weather conditions that may represent a hazard to aviation.

Doppler radar is an important new tool for the weather forecaster and one that will significantly improve the accuracy of very short-term weather forecasts.It promises important benefits to the aviation community in both the en route and terminal areas, and early operational deployment is a high priority objective.

The next generation weather radar [Nexrad] system is an advanced Doppler radar system currently under joint development by the Department of Defense (Air Weather Service), the Department of Transportation (Federal Aviation Administration), and the Department of Commerce (National Oceanic and Atmospheric Administration (National Weather Service).

We have a joint project office to carry this program out staffed by people from all three agencies.

The new radar will be able to measure directly the speed, direction of movement, and changes in direction of precipitation, wind fields, and other weather phenomena, as well as estimating precipitation rates.

The velocity measuring capability, which does not exist in currently operational weather radar systems, will provide additional high quality meteorological data that air traffic controllers, airport operators, and pilots need to make better decisions concerning operational safety.

I have already indicated that a Doppler radar system such as nexrad can improve our recognition of wind shear, gust fronts, downbursts, and other potentially hazardous weather conditions. My enthusiasm for the potential benefits of this new system must, however, be balanced with a few words of caution.

First, the basic technology to address the problems outlined earlier does exist. But we must be careful to recognize that the technology alone is not enough. Sophisticated signal processing systems must be developed to take the basic data and present it to a busy

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radar operator or an aviation user in a clear, unambiguous, and easily understandable way.

In other words, we must take what we saw this morning and do many of the analyses of that so that the information pops out rather quickly and can be relayed quickly and efficiently into the air traffic system.

Equipment incorporating the technology must be engineered to provide very reliable field operations for many years under adverse weather conditions. These are not just incidental requirements.

Furthermore a system must be established which incorporates the radar, the processing and display system, the system operators, airport operations personnel, and the pilot into an effective decisionmaking process so that this precise weather data with high accuracy and hopefully very low false alarm rate, which comes back to the important point of having credibility in the information that is being given to the pilot, can be used in airport operations and by flight crews who can quickly and accurately comprehend it.

Second, the detection of potentially dangerous weather effects in the immediate vicinity of airport terminals requires that the radar system be located at, or very close to the airport itself. That is for the microbursts and downbursts close to the surface.

Constraints on program size and cost, together with the operational and siting compromises implicit in any joint program, make location of a nexrad radar at all major commercial airports and military air bases an unrealistic goal.

Weather radar coverage of all major air terminals will be provided by nexrad but not at a density with the present plan to permit coverage at the low altitudes of concern in climb out and final approach.

Nexrad implementation will be in four phases. The first, system definition is already underway. We expect to complete that in November of this year. The validation phase will begin in June 1983. That runs for approximately 3 years. The limited production is scheduled to begin in 1986 with the field installation of the operational systems beginning in 1987.

In summary, we recognize that more than any other transportation system, aviation is affected by weather. The transitory and often short-lived nature of hazardous weather phenomena mandates the need for the latest weather information to be in the hands of aircrews, air traffic controllers, dispatchers, and others concerned with the safe and efficient use of the national airspace system.

Achieving a firm and comprehensive physical understanding of the processes that determine the character of thunderstorms is without question one of the most important challenges facing the atmospheric sciences community. There will be scientific and technological opportunities that will enable us to make significant improvements to the services we provide the aviation community.

The National Oceanic and Atmospheric Administration, the Federal Aviation Administration, and other Federal agencies as well as the academic community are joined in a comprehensive, cooperative effort to meet the challenge before us today and are pursuing development of feasible projects as rapidly as resources permit.

Mr. Chairman, this concludes my prepared statement. I would be happy to answer any questions you or the subcommittee members may have.

[The prepared statement of Mr. Hallgren follows:]

STATEMENT BY

RICHARD E. HALLGREN, DIRECTOR

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

AND THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON SCIENCE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

AUGUST 11, 1982

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

I APPRECIATE THIS OPPORTUNITY TO ASSIST IN ASSESSING THE DISTRIBUTION OF WEATHER INFORMATION TO PILOTS THROUGH THE AIR TRAFFIC CONTROL SYSTEM, AND TO DISCUSS THE NEEDS AND OPPORTUNITIES FOR IMPROVEMENT IN ORDER TO REDUCE WEATHER RELATED ACCIDENTS.

THE PRIMARY RESPONSIBILITIES OF THE NATIONAL WEATHER SERVICE OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION ARE TO PROVIDE WARNINGS OF SEVERE WEATHER OR FLOODS IN ORDER TO PROTECT LIVES AND PROPERTY; PROVIDE PUBLIC FORECASTS FOR LAND AND ADJACENT OCEAN AREAS FOR PLANNING AND OPERATIONS; AND PROVIDE WEATHER SUPPORT FOR THE PRODUCTION OF FOOD AND FIBER, MANAGEMENT OF WATER RESOURCES, PRODUCTION, DISTRIBUTION, AND USE OF ENERGY, AND EFFICIENT AND SAFE CONDUCT OF AIR COMMERCE.

THE PRINCIPAL TASK OF THE NATIONAL WEATHER SERVICE IS TO

ISSUE SEVERE WEATHER WARNINGS TO SAVE LIVES AND MINIMIZE PROPERTY LOSS. THE UNITED STATES HAS A GREATER VARIETY OF SEVERE WEATHER THAN ANY OTHER NATION IN THE WORLD. HURRICANES, TORNADOES, FLOODS, FLASH FLOODS, THUNDERSTORMS, AND SEVERE WINTER WEATHER TAKE MANY LIVES AND CAUSE THOUSANDS OF INJURIES EVERY YEAR, DESPITE ADVANCES IN TECHNOLOGY AND FORECASTING SKILLS. THE NATION'S LOSSES FROM THESE EXTREME WEATHER EVENTS IS IN THE BILLIONS EACH YEAR. AND THIS DOES NOT INCLUDE AVIATION, OUR MOST WEATHER SENSITIVE INDUSTRY.

THE AVIATION WEATHER SERVICES PROGRAM IS A COOPERATIVE EFFORT AS DESCRIBED IN A FORMAL MEMORANDUM OF AGREEMENT BETWEEN THE FEDERAL AVIATION ADMINISTRATION OF THE DEPARTMENT OF TRANSPORTATION AND NOAA-NATIONAL WEATHER SERVICE OF THE DEPARTMENT OF COMMERCE. THE NATIONAL WEATHER SERVICE IS RESPONSIBLE FOR PREPARING FORECASTS AND WARNINGS AND THE FEDERAL AVIATION ADMINISTRATION DISSEMINATES THIS WEATHER INFORMATION TO USERS. THIS REQUIRES THE TEAMWORK AND COOPERATION WHICH HAS BECOME A TRADITION BETWEEN OUR TWO AGENCIES.

TODAY, THE NATIONAL WEATHER SERVICE PROVIDES A BROAD RANGE OF PRODUCTS FOR THE AVIATION COMMUNITY. FIFTY-TWO NATIONAL WEATHER SERVICE FORECAST OFFICES PREPARE AIRPORT TERMINAL FORECASTS THREE TIMES PER DAY WITH AMENDMENTS AS NEEDED FOR APPROXIMATELY 500 AIRPORTS IN THE 50 STATES AND IN THE CARIBBEAN. OUR OFFICES ALSO PRODUCE ABOUT 300 INDIVIDUAL ROUTE-ORIENTED FORECASTS THREE TIMES PER DAY FOR THE 48 CONTIGUOUS STATES. THIRTEEN OF THESE OFFICES PREPARE AREA FORECASTS OF AVIATION WEATHER CONDITIONS ACROSS THE ENTIRE COUNTRY TWICE A DAY. THESE SAME OFFICES ISSUE ADVISORIES OF HAZARDOUS WEATHER CONDITIONS FOR

AREAS OF TURBULENCE, ICING, STRONG LOW-LEVEL WINDS, AND/OR EXTENSIVE AREAS OF LOW CLOUDS OR VISIBILITY. WHEN ADVISORIES OF DANGEROUS CONDITIONS ASSOCIATED WITH THUNDERSTORMS ARE WARRANTED, THEY ARE ISSUED EACH HOUR BY AN AVIATION UNIT AT THE NATIONAL SEVERE STORMS FORECAST CENTER IN KANSAS CITY SPECIFICALLY DEDICATED TO THAT TASK.

THE QUESTION OF HOW TO DISSEMINATE WEATHER INFORMATION TO BRIEFERS, CONTROLLERS AND USERS OF THE NATIONAL AIRSPACE SYSTEM IN THE MOST TIMELY AND EFFICIENT MANNER POSSIBLE ESPECIALLY DURING HAZARDOUS WEATHER IS ONE PROBLEM. THE OTHER IS DETECTING AND FORECASTING THE HAZARDS WHICH I'LL DISCUSS LATER.

DISSEMINATING INFORMATION IS ACCOMPLISHED ESSENTIALLY FOR TWO PHASES OF FLIGHT, THE PREFLIGHT PLANNING STAGE AND THE IN-FLIGHT HAZARDOUS WEATHER AVOIDANCE STAGE. IN THE PREFLIGHT STAGE, THE FAA PROVIDES ABOUT 95 PERCENT OF THE PILOT WEATHER BRIEFINGS AND WE PROVIDE ABOUT 5 PERCENT. MANY PILOTS ALSO VIEW AVIATION WEATHER PUBLIC TELEVISION SHOWS TO GET A FIRST OR BROAD VIEW OF THE WEATHER AND THE EXPECTED HAZARDS OF THE DAY.

I THINK WE DO A GOOD JOB IN PROVIDING THE FORECASTS FOR THE PREFLIGHT STAGE AND HAVE ONGOING PROJECTS THAT WILL FURTHER ASSIST US IN ACQUIRING, INTEGRATING, DISPLAYING AND DISSEMINATING INFORMATION. THEY INCLUDE AUTOMATIC SURFACE AND UPPER AIR OBSER[illegible]TIONS AS WELL AS OBSERVING/REPORTING SYSTEMS IN CO[illegible]ERCIAL AIRCRAFT, SYSTEMS FOR MERGING RADAR AND SATELLITE PRESENTATIONS, COMPUTER ASSISTANCE IN PREPARING SHORT TERM TERMINAL FORECASTS AND INTERACTIVE GRAPHIC TECHNIQUES TO PRODUCE A USER ACCESSIBLE NOWCAST/FORECAST DATA BASE.

BUT THE NEED FOR FURTHER IMPROVEMENT IS DRIVEN HOME YEAR AFTER YEAR BY THE ACCIDENT STATISTICS. OF THE 4,000 TO 5,000 GENERAL AVIATION ACCIDENTS OCCURRING ANNUALLY, 20 TO 25 PERCENT INVOLVE WEATHER AS A FACTOR AND ABOUT 40 PERCENT OF ALL FATAL ACCIDENTS ARE WEATHER-RELATED. WHILE WEATHER-RELATED ACCIDENTS INVOLVING COMMERCIAL CARRIERS ARE COMPARATIVELY RARE, SUCH ACCIDENTS MAY FREQUENTLY INVOLVE CONSIDERABLE LOSS OF LIFE. THE NEW ORLEANS AND WASHINGTON ACCIDENTS ARE RECENT TRAGIC EXAMPLES.

WHAT KIND OF WEATHER IS HAZARDOUS? THAT VARIES. FOR THE GENERAL AVIATION PILOT IT IS LOW VISIBILITY AND CEILING, ICING, SEVERE TURBULENCE AND THUNDERSTORMS IN THE EN ROUTE PHASE THAT PRODUCE THE MAJORITY OF ACCIDENTS. HOWEVER, FOR THE COMMERCIAL AVIATION PILOT, THE PRIMARY EN ROUTE HAZARD IS THE THUNDERSTORM AND CLEAR AIR TURBULENCE. IN THE TERMINAL AREA IT'S WIND SHEAR AND ICE OR SNOW.

LET'S LOOK AT THE IN-FLIGHT PHASE. IT IS NECESSARY TO DIVIDE THIS STAGE OF FLIGHT INTO THE EN ROUTE AND TERMINAL PHASES. IN THE EN ROUTE PHASE, ACTIONS HAVE BEEN TAKEN IN RECENT YEARS TO MAKE THE AIRSPACE SAFER.

ONE MAJOR FAA EFFORT IS THEIR EN ROUTE FLIGHT ADVISORY SERVICE WHICH ALLOWS THE SPECIALIST TO TALK DIRECTLY TO THE PILOT EXCHANGING ROUTINE WEATHER INFORMATION OR PROVIDING HELP IN AVOIDING A HAZARDOUS WEATHER SITUATION.

THE SECOND MAJOR EFFORT IS THE CENTER WEATHER SERVICE UNIT PROGRAM. THE PROGRAM PLACES NATIONAL WEATHER SERVICE METEOROLOGISTS AT 21 AIR ROUTE TRAFFIC CONTROL CENTERS WHERE THEY PROVIDE WEATHER CONSULTATION AND ADVICE TO AIR TRAFFIC MANAGERS AND CONTROLLERS WHO, IN TURN, RELAY PERTINENT INFORMATION TO

PILOTS. THIS SYSTEM IS DESIGNED TO GET ESSENTIAL WEATHER INFORMATION MORE QUICKLY FROM THE EXPERTS TO THE AIRBORNE PILOTS. REMOTE RADAR COLOR MONITORS WILL BE INSTALLED, BEGINNING THIS FALL, TO PROVIDE THOSE CENTER WEATHER SERVICE UNIT METEOROLOGISTS WITH DIRECT ACCESS TO REAL-TIME WEATHER RADAR INFORMATION. THIS IS A SIGNIFICANT STEP IN GETTING THE MOST TIMELY INFORMATION TO PILOTS IN BOTH EN ROUTE AND TERMINAL PHASES OF FLIGHT.

THE FAA IS EXAMINING AND TESTING APPROACHES SUCH AS BROADCASTING INSTRUCTIONS AND WEATHER INFORMATION DIRECTLY TO A SCREEN IN THE COCKPIT AND THE CONTINUOUS VOICE BROADCASTS OF POTENTIALLY HAZARDOUS WEATHER INFORMATION.

NOW LET ME TURN TO THE COMPLEX PROBLEM OF PROVIDING WEATHER DATA IN THE TERMINAL ENVIRONMENT. WE ARE ALL AWARE THAT IT IS HERE THAT THE MOST CRITICAL PHASE OF THE FLIGHT OCCURS AND WE ARE BECOMING MORE AWARE OF THE RAPIDLY VARYING WEATHER FACTORS THAT ARE SIGNIFICANT DURING THIS PHASE OF FLIGHT. IN THE EN ROUTE PHASE THE PILOT USUALLY HAS MINUTES OR LONGER TO ALTER COURSE AND AVOID KNOWN HAZARDS. IN ADDITION, THERE ARE FEWER INCOMING INSTRUCTIONS AND THE NUMBER OF FLYING TASKS ARE AT THEIR LOWEST LEVEL. IN CONTRAST, THE DEPARTING OR ARRIVING PILOT HAS ONLY SECONDS IN WHICH TO PERFORM MANY TASKS AND IS ALSO THE RECIPIENT OF LARGE QUANTITIES OF INFORMATION. SINCE THIS IS AN EXTREMELY BUSY PERIOD FOR THE PILOT, THE TERMINAL WEATHER DISSEMINATION SYSTEM HAS TO BE EXTREMELY RESPONSIVE TO REFLECT CHANGING CONDITIONS AND THE INFORMATION HAS TO BE PERTINENT TO THE INDIVIDUAL PILOT'S NEEDS.

THIS INFORMATION CURRENTLY CONSISTS OF THE LATEST AVAILABLE

OBSERVATION AND MAY INCLUDE A SUMMARIZED VERSION OF PERTINENT IN-FLIGHT ADVISORIES. IT IS NORMALLY RECEIVED THROUGH APPROACH CONTROL, A TOWER, OR AN AUTOMATIC TERMINAL INFORMATION SERVICE BROADCAST.

THERE ARE OTHER WEATHER PHENOMENA BEYOND THE COMMONLY RECOGNIZED HAZARDS OF LOW CEILING AND/OR SEVERE THUNDERSTORMS, WHICH, WHILE INVISIBLE TO THE HUMAN EYE, MAY REPRESENT HAZARDS TO AVIATION. SOME OF THESE EFFECTS ARE PARTICULARLY SIGNIFICANT AT THE LOW ALTITUDES OF THE TERMINAL PHASES OF A FLIGHT. NEW SYSTEMS AND ADVANCED TECHNOLOGY CAN HELP US TO IDENTIFY AND LOCATE SOME OF THESE NEWLY RECOGNIZED HAZARDS AND TO REDUCE THEIR PART IN AIRCRAFT ACCIDENTS. AMONG THESE NON-VISIBLE HAZARDS ARE THE FOLLOWING:

- WIND SHEAR, A SIGNIFICANT HAZARD TO AVIATION ESPECIALLY DURING FINAL APPROACHES AND TAKEOFFS.
- GUST FRONTS OR VERY STRONG LOW LEVEL-WINDS OCCURRING IN THE CLEAR AIR AHEAD OF AN ADVANCING THUNDERSTORM. THE SPEED AND DIRECTION OF THESE WINDS MAY BE VERY DIFFERENT FROM THAT OF THE PREVAILING WIND IN THE AREA AHEAD OF THESE "GUST FRONTS" AND, AGAIN, REPRESENT A POTENTIAL CONCERN FOR AIRCRAFT SAFETY. THESE WINDS ARE NOT DIRECTLY VISIBLE TO CONVENTIONAL (NON-DOPPLER) RADAR BUT ARE DETECTABLE IN MANY CASES WITH DOPPLER SYSTEMS.
- DOWNBURSTS RESULT FROM THE COOLING OF A VERTICAL COLUMN OF AIR RESULTING IN DOWNDRAFTS WHICH SPREAD OUT HORIZONTALLY CLOSE TO THE GROUND IN RADIAL PATTERN. AN AIRCRAFT FLYING INTO SUCH A DOWNBURST FIRST ENCOUNTERS

AN INCREASE IN HEAD WINDS AND INCREASED LIFT FOLLOWED WITHIN A VERY SHORT DISTANCE OR TIME BY A SUDDEN SHIFT TO A STRONG TAIL WIND AND LOSS OF FLYING SPEED AND LIFT. IF ENCOUNTERED DURING TAKEOFF OR LANDING AT LOW ALTITUDE THE MARGIN ALLOWED FOR PILOT RESPONSE CAN BE TOO SMALL.

AUTOMATIC WEATHER OBSERVING STATIONS, GROUND-BASED REMOTE SENSING SYSTEMS, DOPPLER RADAR AND GEOSTATIONARY AND LOW ALTITUDE OBSERVING SATELLITES, TOGETHER WITH THE LOW COST MINI AND MICRO-COMPUTER PROMISE THE ABILITY TO IDENTIFY, DETECT, DISPLAY AND COMMUNICATE MORE RELIABLE AND MORE COMPLETE WEATHER DATA ON A REAL-TIME BASIS.

THESE ARE ALL IN VARIOUS STAGES OF DEVELOPMENT AND EVALUATION IN OPERATIONAL ENVIRONMENTS. WE CAN ALSO LOOK FORWARD TO A GREATLY IMPROVED DATA BASE FOR SHORT TERM FORECASTING OF AVIATION WEATHER HAZARDS.

EARLIER I MENTIONED THE EVER INCREASING DANGERS TO AVIATION FROM WIND SHEAR AND DOWNBURSTS. RESEARCH ON THESE PHENOMENA HAS BEGUN IN THE PAST FIVE YEARS. WE ARE ALL AWARE OF THE JOINT AIRPORT WEATHER STUDIES PROJECT. THIS IS A VERY PRODUCTIVE STUDY BEING CONDUCTED IN COLORADO UNDER THE AUSPICES OF THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH IN BOULDER, COLORADO, AND THE UNIVERSITY OF CHICAGO, SPONSORED BY THE NATIONAL SCIENCE FOUNDATION, THE FAA, NOAA, AND NASA.

THE PRINCIPLE OBJECTIVE OF THIS PROJECT IS TO GAIN INSIGHTS INTO THE SMALL SCALE METEOROLOGICAL CONDITIONS ASSOCIATED WITH THUNDERSTORMS PARTICULARLY AT LOW LEVELS. THE STUDY GROUP IS

TESTING AN ARRAY OF WIND SHEAR DETECTION INSTRUMENTATION IN A DENSE AUTOMATED OBSERVATION NETWORK AT DENVER'S STAPLETON AIRPORT AND IS USING THREE DOPPLER RADAR SYSTEMS AND RESEARCH AIRCRAFT. THEY HOPE TO BE ABLE TO FOLLOW THE ENTIRE DOWNBURST LIFE CYCLE AND THEN COMPARE THE RESULTS WITH VISUAL OBSERVATIONS.

THE ABILITY OF DOPPLER RADAR TO DETECT THUNDERSTORM DOWNBURSTS AND WIND SHEAR CONDITIONS HAS BEEN DEMONSTRATED. THERE HAVE BEEN SOME EXCITING FINDINGS WITH SIGNIFICANT IMPLICATIONS FOR AVIATION SAFETY. THEY HAVE FOUND DOWNBURSTS AND WIND SHEAR PRODUCED BY INNOCENT LOOKING CUMULUS CLOUDS AS WELL AS IMBEDDED IN THE MAIN THUNDERSTORM CELLS. THEY FOUND THAT DOWNBURSTS LAST AN AVERAGE OF ONLY FIVE MINUTES AND COVER AN AREA OF A FEW MILES IN DIAMETER OR LESS.

MR. CHAIRMAN, I HAVE, DURING THE COURSE OF MY TESTIMONY, MADE SEVERAL REFERENCES TO THE USE OF DOPPLER RADAR IN THE DETECTION OF WEATHER CONDITIONS THAT MAY REPRESENT A HAZARD TO AVIATION. DOPPLER RADAR IS AN IMPORTANT NEW TOOL FOR THE WEATHER FORECASTER AND ONE THAT WILL SIGNIFICANTLY IMPROVE THE ACCURACY OF VERY SHORT-TERM WEATHER FORECASTS. IT PROMISES IMPORTANT BENEFITS TO THE AVIATION COMMUNITY IN BOTH THE EN ROUTE AND TERMINAL AREAS, AND EARLY OPERATIONAL DEPLOYMENT IS A HIGH PRIORITY OBJECTIVE.

THE NEXT GENERATION WEATHER RADAR (NEXRAD) SYSTEM IS AN ADVANCED DOPPLER RADAR SYSTEM CURRENTLY UNDER JOINT DEVELOPMENT BY THE DEPARTMENT OF DEFENSE (AIR WEATHER SERVICE), THE DEPARTMENT OF TRANSPORTATION (FEDERAL AVIATION ADMINISTRATION) AND THE DEPARTMENT OF COMMERCE (NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION - NATIONAL WEATHER SERVICE)

THE NEW RADAR WILL BE ABLE TO MEASURE DIRECTLY THE SPEED, DIRECTION OF MOVEMENT AND CHANGES IN DIRECTION OF PRECIPITATION, WIND FIELDS, AND OTHER WEATHER PHENOMENA, AS WELL AS ESTIMATING PRECIPITATION RATES. THE VELOCITY MEASURING CAPABILITY, WHICH DOES NOT EXIST IN CURRENTLY OPERATIONAL WEATHER RADAR SYSTEMS, WILL PROVIDE ADDITIONAL HIGH QUALITY METEOROLOGICAL DATA THAT AIR-TRAFFIC CONTROLLERS, AIRPORT OPERATORS, AND PILOTS NEED TO MAKE BETTER DECISIONS CONCERNING OPERATIONAL SAFETY.

I HAVE ALREADY INDICATED THAT A DOPPLER RADAR SYSTEM SUCH AS NEXRAD CAN IMPROVE OUR RECOGNITION OF WIND SHEAR, GUST-FRONTS, DOWNBURSTS, AND OTHER POTENTIALLY HAZARDOUS WEATHER CONDITIONS. MY ENTHUSIASM FOR THE POTENTIAL BENEFITS OF THIS NEW SYSTEM MUST, HOWEVER, BE BALANCED WITH A FEW WORDS OF CAUTION.

FIRST, THE BASIC TECHNOLOGY TO ADDRESS THE PROBLEMS OUTLINED EARLIER DOES EXIST. BUT WE MUST BE CAREFUL TO RECOGNIZE THAT THE TECHNOLOGY ALONE IS NOT ENOUGH. SOPHISTICATED SIGNAL PROCESSING SYSTEMS MUST BE DEVELOPED TO TAKE THE BASIC DATA AND PRESENT IT TO A BUSY RADAR OPERATOR OR AN AVIATION USER IN A CLEAR, UNAMBIGUOUS AND EASILY UNDERSTANDABLE WAY. EQUIPMENT INCORPORATING THE TECHNOLOGY MUST BE ENGINEERED TO PROVIDE VERY RELIABLE FIELD OPERATIONS FOR MANY YEARS UNDER ADVERSE WEATHER CONDITIONS. THESE ARE NOT JUST INCIDENTAL REQUIREMENTS. FURTHERMORE, A SYSTEM MUST BE ESTABLISHED WHICH INCORPORATES THE RADAR, THE PROCESSING AND DISPLAY SYSTEM, THE SYSTEM OPERATORS, AIRPORT OPERATIONS PERSONNEL, AND THE PILOTS INTO AN EFFECTIVE DECISION MAKING PROCESS SO THAT THIS PRECISE WEATHER DATA WITH HIGH ACCURACY AND LOW FALSE ALARM RATE CAN BE USED IN AIRPORT

OPERATIONS AND BY FLIGHT CREWS WHO CAN QUICKLY AND ACCURATELY COMPREHEND IT.

SECOND, THE DETECTION OF POTENTIALLY DANGEROUS WEATHER EFFECTS IN THE IMMEDIATE VICINITY OF AIRPORT TERMINALS REQUIRES THAT THE RADAR SYSTEM BE LOCATED AT, OR VERY CLOSE TO THE AIRPORT ITSELF. CONSTRAINTS ON PROGRAM SIZE AND COST, TOGETHER WITH THE OPERATIONAL AND SITING COMPROMISES IMPLICIT IN ANY JOINT PROGRAM, MAKE LOCATION OF A NEXRAD RADAR AT ALL MAJOR COMMERCIAL AIRPORTS AND MILITARY AIR BASES AN UNREALISTIC GOAL. WEATHER RADAR COVERAGE OF ALL MAJOR AIR TERMINALS WILL BE PROVIDED BY NEXRAD BUT NOT AT A DENSITY TO PERMIT COVERAGE AT THE LOW ALTITUDES OF CONCERN IN CLIMB OUT AND FINAL APPROACH.

NEXRAD IMPLEMENTATION WILL BE IN FOUR PHASES. THE FIRST, SYSTEM DEFINITION, WILL DETERMINE THE CAPABILITIES OF THE OPERATIONAL SYSTEM AND HOW BEST TO BALANCE THE DIFFERENT PRIORITIES OF THE THREE AGENCIES AT MINIMUM COST. THIS PHASE IS NOW UNDERWAY AND WILL BE COMPLETED IN NOVEMBER OF THIS YEAR.

THE VALIDATION PHASE WILL BEGIN IN JUNE 1983. CONTRACTORS WILL DESIGN, BUILD, AND TEST TWO COMPETING PRE-PRODUCTION MODELS OF THE OPERATIONAL NEXRAD SYSTEM. LIMITED PRODUCTION IS SCHEDULED TO BEGIN IN 1986, WITH FIELD INSTALLATION OF OPERATIONAL SYSTEMS BEGINNING IN 1987.

IN SUMMARY, WE RECOGNIZE THAT MORE THAN ANY OTHER TRANSPORTATION SYSTEM, AVIATION IS AFFECTED BY WEATHER. THE TRANSITORY AND OFTEN SHORT-LIVED NATURE OF HAZARDOUS WEATHER PHENOMENA MANDATES THE NEED FOR THE LATEST WEATHER INFORMATION TO BE IN THE HANDS OF AIR CREWS, AIR TRAFFIC CONTROLLERS, DISPATCHERS, AND OTHERS CONCERNED WITH THE SAFE AND EFFICIENT USE

OF THE NATIONAL AIRSPACE SYSTEM. ACHIEVING A FIRM AND COMPREHENSIVE PHYSICAL UNDERSTANDING OF THE PROCESSES THAT DETERMINE THE CHARACTER OF THUNDERSTORMS IS WITHOUT QUESTION ONE OF THE MOST IMPORTANT CHALLENGES FACING THE ATMOSPHERIC SCIENCES COMMUNITY. THERE WILL BE SCIENTIFIC AND TECHNOLOGICAL OPPORTUNITIES THAT WILL ENABLE US TO MAKE SIGNIFICANT IMPROVEMENTS TO THE SERVICES WE PROVIDE THE AVIATION COMMUNITY. THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, THE FEDERAL AVIATION ADMINISTRATION, AND OTHER FEDERAL AGENCIES AS WELL AS THE ACADEMIC COMMUNITY ARE JOINED IN A COMPREHENSIVE, COOPERATIVE EFFORT TO MEET THE CHALLENGE BEFORE US TODAY AND ARE PERSUING DEVELOPMENT OF FEASIBLE PROJECTS AS RAPIDLY AS RESOURCES PERMIT.

MR. CHAIRMAN, THIS CONCLUDES MY PREPARED STATEMENT. I WOULD BE HAPPY TO ANSWER ANY QUESTIONS YOU OR THE SUBCOMMITTEE MEMBERS MAY HAVE.

Mr. GORE. Thank you very much.

Mr. Dunn.

Mr. DUNN. I have a question of a general nature. The chairman quite correctly has been talking about lack of communication in some areas. But when you have NASA funding, DOD funding, DOE funding, and you have Flight Service Stations, the National Weather Service, and FAA—can we consolidate some of these functions into one organization, probably under FAA?

Mr. HALLGREN. Do you mean all of aviation weather?

Mr. DUNN. Well, I believe that aviation weather information can also be used for other purposes, such as whether or not you and I should go fishing this weekend. They use the same information.

Mr. HALLGREN. My own view is, of course, there is always the complicated problem of where weather services should be.

I also work internationally in my role as the U.S. permanent representative to the WMO and we frequently discuss where weather services are located in other countries. It turns out there is no exactly right home. Some are in agriculture departments, some are in transportation departments, some are in commerce departments. In fact, in Norway it is in the Department of Church. And I thought that was a good place for it.

But the point I am trying to get at is that the system of providing weather services is very entwined. The thing that I would want to see, wherever it is put, is that it be kept together as one.

In other words, the forecast, as I have indicated earlier, whether it is a public forecast for a severe tornado warning, or a sigmet for a particular area, it is most efficient to have it prepared by one agency.

Mr. DUNN. Could I interrupt the witness? We have a vote.

Mr. GORE. They need a quorum to report the bill out.

Mr. DUNN. I want to stay on that if we might come back for 5 minutes.

Mr. GORE. With your indulgence we will come back in 5 minutes and finish it up.

[Recess.]

Mr. GORE. The subcommittee will come back to order.

Mr. Dunn.

Mr. DUNN. You were in the process of answering my question as to whether or not we might be able to combine some of these agencies. Without dragging out your answer, it seemed to be yes.

Let me just conclude by saying I might suggest to the two distinguished chairmen here that this might be a subject for future hearings in this area of better communications. These subcommittees and other committees involved might consider the amalgamation of those agencies which provide weather services such as the FAA and National Weather Service into one agency.

I thank the chairman and the witness.

Mr. GORE. Thank you.

Chairman Glickman.

Mr. GLICKMAN. I am sorry, Mr. Hallgren, I was not able to appear for your testimony. I was in the full committee. That doesn't mean I wasn't interested in it. I am. Your role in this whole area is probably the key role, as the weather predictors you will determine the information given the airline system in order to perform their task well.

I think we have some institutional problems in the conveyance of weather information from you to the appropriate people at the end of the stream.

We may have some additional questions for you that I hope we can submit to you in writing and that you would answer. I note the National Weather Service is working under very severe budgetary constraints.

Mr. HALLGREN. I am happy you noticed that.

Mr. GLICKMAN. A lot of those will relate to issues like should we close Weather Service Offices or not, which would become a big political item up here. But I am naturally hopeful that in no way will that jeopardize the adequate prediction and dissemination of weather information either to pilots or to anybody else who is interested in it. And just one question.

In any way are the current budgetary constraints you are operating under causing you to deteriorate your service, generally, to either—well, to the aviation arena?

Mr. HALLGREN. The support that we have had to the aviation community in the Weather Service has not changed by any significant amount. We have a total program of $26.7 million in the Weather Service that is identified in support of aviation.

The only proposal that has come up to the Congress was to consolidate the aviation area forecasting as a single center, which is about a $350,000 decrease. In that proposal we were going to prepare those area forecasts at a single point in Kansas City instead of the 9 points across the country. Otherwise, our program has not been cut in that area.

The concern, of course, that we always have is whether our observational network is staying intact well enough to handle the forecasts across the whole country, whether it is for public forecasting or for aviation purposes.

Mr. GLICKMAN. I might note for the record that it was this subcommittee, particularly subcommittee staff, who during the ADAP conference recently made sure that FAA meteorologists in the centers were included in the 1983 to 1987 budgets in the ADAP bill.

As I understand, they will be paid from the trust fund which has been agreed to in the House-Senate spending part of the aviation bill, $26½ million in 1983 through $37 million in 1987.

Mr. HALLGREN. Could I clarify that?

Mr. GLICKMAN. That is an estimate.

Mr. HALLGREN. To make sure. We have been talking about it. What we have is that for a long period of time, decades, the funds for the Weather Service support of aviation were included in the Weather Service budget and appropriated to the Department of Commerce/Weather Service. In the last year or so, the decision was made that the users should pay for these services. That is fine with me, as long as we do get the funds so we can do what we are required to do.

And the proposal went forward for the $26.7 million to come out of the trust fund. And I believe it is now gradually getting straightened out on the Hill that that is the way it will go. That $26.7 million does not include the funding for the CWSU staff at the 21 air traffic control centers. That has always been directly transferred to us by FAA since the inception of the program.

Mr. GLICKMAN. Those were the numbers that Mr. Gore was trying to pin down with the FAA witness, as to what those numbers were going to be. And he couldn't give Mr. Gore a response.

Mr. HALLGREN. That was the $26.7 million that Mr. Gore was questioning on. On the CWSU's, that has always been in the FAA budget and would be transferred to us. That is in addition to the $26.7 million.

Mr. GLICKMAN. I thank you for your testimony. I want to thank Mr. Gore for being the chairman of this today. I think these were very useful hearings. Hopefully, the subcommittees will perhaps come through with an additional set of recommendations that we will issue.

Thank you.

Mr. GORE. Let me ask just one brief question.

First of all, you will be willing to submit to additional questions in writing?

Mr. HALLGREN. Yes.

Mr. GORE. The position Mr. Connolly used to fill is still unfilled. You had an oral addition to your statement saying that in effect you were trying to do that yourself. That is essentially in response to the implied criticism of the current organizational framework, right?

Mr. HALLGREN. Well, I was trying to speak to it from the Weather Service side. I felt that that was a better way of handling it, as I said, since it was so integrated. So I decided to work both of those programs.

Mr. GORE. Well, sometimes when I identify some problem in my office operation, I will try to just do it myself instead of figuring out how somebody else——

Mr. HALLGREN. It was a very deliberate action on my part. I have consciously made that decision to eliminate that particular position.

Mr. GORE. You did?

Mr. HALLGREN. Yes, I personally made that decision so you can come right at me, Mr. Chairman. I personally made the decision to take that position. I felt it would be better. It cuts too much across all the Weather Service. I have to be personally involved. To pass it off to someone spending half time at FAA and half time in the Weather Service, it doesn't work as well as doing that yourself.

Mr. GORE. Of course, to be candid, while your budget is being cut that rapidly, you don't have that much choice.

Mr. HALLGREN. No; it wasn't related to a budget decision at that time. That was my decision.

Mr. GORE. Well, we have a vote. I am going to thank you for being here and thank all the witnesses. I think we have had an excellent set of hearings, and certainly appreciate your help.

With that we will stand adjourned.

[Whereupon, at 3:25 p.m., the subcommittees were adjourned.]

98-983 O—82——11

Statement Regarding the Joint Airport Weather Studies Project

By Dr. John McCarthy

National Center for Atmospheric Research

The Joint Airport Weather Studies (JAWS) Project was originally conceived in April 1980 as an outgrowth of the evolution of three scientific investigations: The Northern Illinois Meteorological Research on Downbursts (NIMROD) by Dr. Theodore Fujita of the University of Chicago; aircraft performance and Doppler radar studies of low-level wind shear by Dr. John McCarthy of the National Center for Atmospheric Research (NCAR); and the operational uses of Doppler radar by Mr. James Wilson, also of NCAR. The JAWS Project is a joint project of the University of Chicago and the National Center for Atmospheric Research, the latter being funded by the National Science Foundation. Fujita, McCarthy and Wilson serve as Project co-investigators.

The principal objectives of JAWS is additional basic knowledge on microbursts and their environment to help scientists understand what causes them and how they can be detected and predicted. The microburst is defined as a downdraft and radial outflow near the surface having an horizontal extent less than 4 km (2.4 miles). Expected maximum horizontal wind speeds in a microburst are 20 to 60 m/s (meters per second) lasting between 2 to 8 min. The low-level wind shear associated with the microburst has been implicated as a cause of several major aviation accidents, primarily because the microburst when penetrated in any direction, whether on takeoff or landing, produces a severe loss of lift to jet transport aircraft.

The basic questions being pursued by JAWS are the following: (1) Why don't microbursts occur in all thunderstorms? (2) What physical mechanisms are responsible for generating microbursts? (3) Why do dangerous microbursts sometimes occur in association with clouds much smaller than thunderstorms? (4) Is there a particular region within the cloud in which

the microburst originates? (5) How can the aviation system best detect microbursts in an accurate and timely manner, and (6) Can the aviation system do a much better job of simulating microburst wind shears for pilot training and airborne detection and warning needs?

A large collection of data gathering devices were assembled to address low-level wind shear including: 3 pulsed microwave Doppler radars, 2 pulsed CO_2 Doppler lasers, 41 surface automated weather stations, 5 research aircraft which included 1 airborne Doppler lidar system for wind shear detection and 1 airborne research microwave Doppler radar system. All research activities were concentrated around Denver's Stapleton International Airport.

Low-level wind shear detection and warning systems that were tested included the Low-Level Wind Shear Alert System (LLWSAS) of the FAA, a similar NCAR ground-based wind system of a greater density than the LLWSAS, a pressure jump sensor array, and three airborne systems: the airspeed and groundspeed procedure concept, an airborne laser detection system, and the Smith's Industries vertical velocity/Energy Rate System. Finally, one of the NCAR pulsed microwave Doppler radars was placed at the airport center as a primary detection and warning system.

During the field experiment from 15 May to 13 August 1982, data were collected on approximately fifty microbursts in good dual Doppler radar coverage. This should make it possible to obtain excellent four-dimensional analysis of microburst wind speeds. Numerous additional data exist on downbursts (large-scale microbursts), gust fronts, mesocyclones, tornadoes, funnel clouds, hailstorms, and flash floods.

Analysis priorities include the preparation of the following:

- High resolution, four-dimensional microburst profiles for improved manned-flight simulation
- Microburst frequency distribution
- Quantitative ordering of detection and warning critical success ratios
- Training film for pilots describing the microburst which will enable pilots to recognize visual clues and avoid hazardous conditions
- Quantification of wind shear severity
- Doppler radar siting to establish suitable detection range as a function of hazard
- Research vs. training simulation response to microburst wind shear profiles
- A close relationship with The United Kingdom's Royal Aircraft Establishment for data analysis of airborne detection and warning systems

We have several initial impressions that are worthy of mention. Of course, definitive conclusions must await a careful analysis. However, we feel it is important to present to this committee preliminary impressions concerning low-level wind shear. First of all, in Denver, microbursts are quite common and although small and short-lived, can be lethal. Accidents involving microbursts are rare because the space-time window is very small when a jet aircraft will encounter a microburst below 500 ft altitude. The current low-level wind shear alert system (LLWSAS) appears to be inadequate to detect and warn of microburst occurrences primarily because microbursts are smaller than the LLWSAS detection scale.

It appears that current training simulators do an inadequate job of responding to wind shear gust input since the microburst signal is likely to excite this mode in a manner critical to jet transport safety. Furthermore, we believe that current wind shear models used in simulation are inadequate because they do not represent the microburst scale with sufficient resolution to be accurate and useful.

We believe that pilots and controllers alike are insufficiently aware of the microburst hazard threat and the current inadequacies in its detection and warning. Therefore, a training film highlighting these points is vital.

We have a strong impression that an airport-located pulsed microwave Doppler radar, if used in an extremely timely manner, can provide an order of magnitude increase in aviation system (pilot and/or controllers) protection from dangerous wind shear.

The extensive JAWS data set will enable scientists to take a quantum step in solving the wind shear problem. However, with any project of this scope, thorough analysis will require full support of mission agencies participating in the project as well as stable, long-term funding. Mission agencies appropriate to this need are the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration and the Federal Aviation Administration. Stable, long-term funding in the basic science arena is anticipated through the National Science Foundation and its National Center for Atmospheric Research.

ALLIED PILOTS ASSOCIATION

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August 24, 1982

The Honorable Dan R. Glickman
Chairman
Subcommittee on Transportation,
Aviation & Materials
U.S. House of Representatives
1507 Longworth House Office Building
Washington, DC 20515

Dear Mr. Glickman:

I greatly appreciate the opportunity to belatedly make this statement for the record. We regret that the Allied Pilots Association, which represents approximately 4,000 pilots employed by American Airlines, Inc., was unable to be present at the hearings of August 11, 1982. We feel, however, that this statement may be of assistance to your committee by providing additional insight and definition to the problem.

The recent tragedy at New Orleans dramatically highlights the need for improved weather information in the cockpits of this nation's airliners. The Honorable J. Lynn Helms recently convened the National Airspace Review under which the specific assignment of NAR Task Group 1-4 was to review regulations concerning weather, the weather product, and weather dissemination. Several of the speakers on August 11, 1982, referred to the work of this group and we would like to call to your attention recommendations 1-4.1.21 and 1-4.1.22 that emanated from Task Group 1-4.

ALPA pointed out several areas of concern, one of which was putting "real-time" weather radar information into the cockpit of our nation's airliners. The existing NWS/FAA ground based S-band color weather radar network is in many ways superior to airborne weather radar. Experiments have already been conducted that prove that the existing network can be linked to the cockpit. Task Group 1-4 recommendation .1.21 addresses that need. It is recognized, however, that as the NEXRAD Doppler network evolves, the practicality of designing and putting the machinery in place will cause the implementation of this most desirable feature to be in the somewhat distant future. We at APA agree with ALPA for the need, but we would like to proffer an interim solution that would be cost effective and beneficial to the traveling public until a final solution can be implemented.

One of the ironies in aviation today is that the housewife watching television is better informed about "real-time" weather events than the captain who is about to enplane and assume responsibility for a 40 million dollar aircraft. The housewife is watching weather being transmitted from the NWS/FAA color weather radar network that hundreds of commercial television stations have access to. One of the anomolies of the FAR's is that meteorology departments are in place to support and brief the dispatcher, not the pilot. The dispatcher then briefs the pilot. As has been pointed out, this concept evolved from the 30's, the era of the DC-3's. In today's age of high speed airplanes, computers and communications the concept may be flawed. In the past the pilot would receive a briefing directly from meteorology personnel. Today's cost conscience airline managements now apply a stricter interpretation of the FAR's, due to the economic pressure of de-regulation. Hence, the pilot gets his weather information, "by regulation", that is filtered through the dispatcher. Dispatchers are like housewives, in that they too, at many companies, have access to the NWS/FAA radar network. The pilots position, though, has not changed. There is no requirement for him to have access to this valuable tool.

We would like to highlight the NAR 1-4.1.22 recommendation that changes FAR 121.601, to require this essential tool be available to the airline crew prior to take off. Previous speakers have stated that, like the housewife, the controllers in the center, the meteorologist at the CWSU, and the FSS briefers will have direct access to the NWS/FAA color weather radar network. We believe that the ultimate decision maker, the pilot, should also be able to use this invaluable tool, one that is in place and available today. The deployment and implementation of the existing network would be a cost effective method at preventing future severe weather accidents.

We at APA appreciate the opportunity to submit this statement and stand ready to assist the subcommittee in anyway possible.

Sincerely,

R. H. Malone

R. H. Malone
President

RHM:sc

AIR LINE PILOTS ASSOCIATION
1625 MASSACHUSETTS AVENUE, N.W. □ WASHINGTON, D.C. 20036 □ (202)797-4000

August 25, 1982

The Honorable Dan Glickman
Chairman of the House Science
and Technology Subcommittee
on Transportation, Aviation
and Materials
Suite 2321
U.S. House of Representatives
Washington, DC 20515

The Honorable Al Gore
Chairman of the House Science
and Technology Subcommittee
on Oversight and Investigations
Suite 2321
U.S. House of Representatives
Washington, DC 20515

Gentlemen:

First, I would like to congratulate you and your Subcommittees on your excellent report on Aviation Safety Research and the associated special recommendations on ways to improve aviation safety.

Your recent hearing on aviation weather and the real-time dissemination of weather information to pilots and controllers was both timely and necessary. In our testimony before your subcommittees we presented recommendations on both short-term and long-term changes to our weather observation and reporting procedures which would improve the dissemination of weather information. There are two matters contained in our testimony which I feel need to be emphasized now, since both of these items require immediate action: The first matter is the inability of the National Weather Service to provide useful data on their radar summary chart. This chart is prepared through utilization of Storm Detection radar reports to locate all significant thunderstorms that exist in the domestic United States at the time a map is prepared. As we pointed out during our testimony, the usefulness of this map is sometimes limited by breakdowns in the internal reporting processes of the National Weather Service. Radar information on severe storms is available, it just is not getting to the radar summary chart. The second matter is the National Weather Service's proposed conversion of the present Radar Azimuth and Range (AZRAN) code to an all digital format. The present AZRAN code is utilized to disseminate radar information on the location of thunderstorms. The proposed all digital radar code would not improve the timeliness or the accuracy of the weather observations presently disseminated to users. In fact, it could have just the opposite effect. As we pointed out in our testimony, the accuracy of the all digital code has been called into question by every aviation user group that has reviewed the proposed change.

We strongly recommend that the proposed November 1, 1982 implementation date of the all digital radar code be postponed until a more suitable method can be derived for the dissemination of this vital weather information. If you or your staff have any questions on our recommendation, we would be happy to meet with you at your convenience to discuss our proposal in more detail.

The Air Line Pilots Association appreciates your interest and support in improving aviation safety.

Sincerely,

J. J. O'Donnell, President

JJO'D:pg

Air Transport Association OF AMERICA

1709 New York Avenue, N.W.
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Phone (202) 626-4021

John E. Ralph
Senior Vice President
Operations and Technical Support

August 18, 1982

The Honorable Dan Glickman
Chairman
Subcommittee on Transportation
Aviation and Materials
Committee on Science and Technology
U. S. House of Representatives
Washington, D. C. 20515

The Honorable Albert Gore, Jr.
Chairman
Subcommittee on Investigations and
Oversight
Committee on Science and Technology
U. S. House of Representatives
Washington, D. C. 20515

Dear Messrs. Chairmen:

Several staff members from the Air Transport Association attended your August 11, 1982 joint hearing which assessed weather support to the aviation community. Please accept our thanks for illuminating some of the problems in this area.

One of the recommendations that was made by several witnesses, either in their formal statements or during discussions, referred to the need for a position within government to manage and coordinate aviation weather services between the National Weather Service, the Federal Aviation Administration, and the aviation community at large. One witness, Mr. John Connolly, formerly held such a position under the National Oceanic and Atmospheric Administration until 1979. Mr. Connolly stated, "The position was never filled upon my departure, and I think it was a serious mistake". Another witness, Mr. Paul Kadlec, identified the fact that the first recommendation of Task Group 1-4 of the FAA's National Airspace Review of weather programs was that the FAA Administrator should designate a position at the highest staff level to manage and coordinate aviation weather services. Additionally, Mr. Jack Howell, of the Air Line Pilots Association stated, "The last point I would like to make Mr. Chairmen, is about the obvious lack of direction in aviation weather services. Within the FAA, the responsibility for weather is so fragmented that there does not appear to be any direction to near-term services or a cohesive long-term program".

Messrs. Chairmen, the airlines are also concerned about the lack of a weather focal point in the FAA. ATA strongly endorses the need for a senior aviation weather specialist in the Federal Aviation Administration. The position should be established at the highest staff level, and the purpose of the position should be to provide centralized management and coordination of aviation weather services.

Again, we are most appreciative of the public review of weather support to the aviation community that your hearing provided.

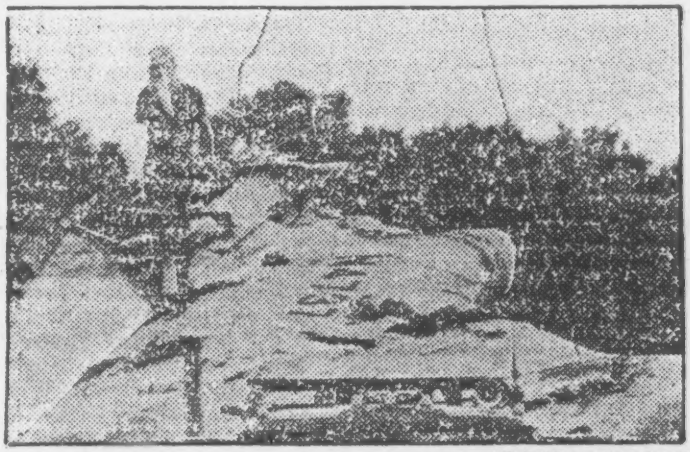
Sincerely,

John E. Ralph
Senior Vice President
Operations and Technical Support

Wednesday, August 4, 1982

The Washington Post ··· A17

CLEARANCE DENIED . . . Something that never happens in aviation is for the air traffic control tower to deny an airplane permission to take off because of weather. Instead, controllers radio information to the pilot, who decides whether to fly. The Pan American World Airways crash in New Orleans on July 9, which killed 154 people, has spawned several suggestions to the effect that the tradition needs reexamining.



United Press International

Nader group says this New Orleans plane crash could have been prevented.

Yesterday the Aviation Consumer Action Project, a Ralph Nader organization, petitioned the **National Transportation Safety Board** to recommend that, if airport monitoring devices are showing the kinds of dangerous, shifting winds recorded in New Orleans, takeoff approval be denied. "We believe, based on currently public information, that the crash . . . would have been prevented if the tower had been required to close the runway after receiving wind-shear alerts," the group said. " . . . A wind-shear alert 'speaks for itself' and does not require controller interpretation; and wind-shear alerts indicate a hazard that should prevent takeoff."

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NEWS from acap

AVIATION CONSUMER ACTION PROJECT
P.O. BOX 19029 WASHINGTON, D.C. 20036
TELEPHONE (202) 223-4498

FOR RELEASE: TUESDAY AM
AUGUST 3, 1982

CONTACT: MATTHEW FINUCANE, 223-4498

ACAP SAYS CLOSE RUNWAYS AFTER WIND SHEAR ALERTS TO PREVENT NEW ORLEANS TYPE CRASH

WASHINGTON, D.C., August 3 --- Stating that "the crash of Pan Am Flight 759 in New Orleans would have been prevented if the tower had been required to close the runway after receiving wind shear alerts", the Aviation Consumer Action Project called today for rules requiring controllers to deny take-off clearances when they receive such alerts.

Wind shear alerts go off in the control towers at major airports when there is a wind shear of 15 knots or more near a runway. Wind shear is a rapid shift in wind direction and speed which can suddenly decrease lift and cause a plane to crash. Under current rules, air traffic controllers simply pass wind shear alerts on to pilots and it is up to the crew to decide whether or not to take off.

In a letter to National Transportation Safety Board Chairman James Burnett, the Nader-founded ACAP said that grounding was necessary because alerts do not go off unless there is a "hazard" and because the original purpose of the alerts was to "allow pilots to avoid wind shear rather than adjust to fly through it." ACAP said that the hazardous nature of the 15 knot shear which triggers the alert is recognized by Continental Airlines, which prohibits pilots from taking off when there is a 15 knot shear, and by the manufacturer of the alerting system, Sangamo/Weston Industrial Systems. According to ACAP, Sangamo Weston believes that aircraft should be required to stay on the ground for 15 minutes after a wind shear alert.

The ACAP letter, signed by its Director Matthew Finucane, argues that automatic closing of runways after wind shear alerts would prevent accidents caused by "communication lapses between the tower and the pilot" and accidents caused by "pilot error." According to ACAP, it would also "protect pilots in a specific hazardous situation from any management, peer group, or other pressures that may encourage them to take off."

ACAP said it was asking the Board to make the recommendation to the FAA because of its expertise in weather-related crashes and because of the relationship of the recommendation to the New Orleans crash. ACAP today also asked the Federal Aviation Administration to consider the proposal.

acap

AVIATION CONSUMER ACTION PROJECT
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Delfina Mott
Esther Peterson
Shelby Southard

August 3, 1982

Honorable James Burnett
Chairman
National Transportation Safety Board
Washington, DC 20594

Dear Mr. Burnett:

We are writing to urge that the National Transportation Safety Board make an urgent recommendation to the Federal Aviation Administration that controllers deny clearances for take-off for a fixed period of time when there is a wind shear alert on the Low Level Wind Shear Alert System (LLWSAS).[1] We believe, based on currently public information, that the crash of Pan Am Flight 759 in New Orleans would have been prevented if the tower had been required to close the runway after receiving wind shear alerts.

As you know, controllers are currently required to simply

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1 LLWSAS is a computer controlled display in the control tower at major airports of wind direction and speed measured at six points on the airport: one in the center and five at take-off areas near the boundary of the airport. LLWSAS alerts the controller with visual and audible alarms when the difference in wind direction and speed at a boundary and at the center of the airport is 15 knots or more and provides the controller with the boundary wind speed and direction.

pass along wind shear alerts to the pilots and it is up to the pilots to decide whether to take-off or land.[2] We believe that the decision-making power in this specific, limited situation should be transferred to the tower since the tower has the most up-to-date information on wind shear alerts, a wind shear alert "speaks for itself" and does not require controller interpretation, and wind shear alerts indicate a hazard that should prevent take-off. In addition, automatic denial of take-off clearances when there is a wind shear alert will prevent accidents caused by communication lapses between the tower and the pilots and caused by pilot error. It would also protect pilots in a specific, hazardous situation from any management, peer group, or other pressures that may encourage them to take off.

Such a recommendation would be consistent with the Board's recommendation on April 1, 1976 that the FAA:

> Revise appropriate air traffic control procedures to specify that the location and severity of thunderstorms be considered in the criteria for selecting active runways. (A-76-37).

This recommendation was made as a result of the Board's investigation into the June 24, 1975 crash of an Eastern Airlines Boeing 727 at John F. Kennedy airport. The Board attributed this accident to wind shear associated with a thunderstorm. Contributing to the accident, according to the Board, "was the continued use of runway 22L when it should have become evident to both air traffic control personnel and the flightcrew that a severe weather hazard existed along the approach path."[3]

This recommendation was similar to the following (April 18, 1974) recommendation made after an accident involving an

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[2] Although a recent (July 16) NTSB press release on the Pan Am crash implied that the pilots took off even though they had received two wind shear alerts, we have yet to see any evidence from the NTSB that the crew received the timely, detailed wind shear information that controllers would have been required to give under Paragraph 981 of the Air Traffic Controller handbook if there were wind shear alerts relevant to their flight. It is therefore not the intention of this letter to imply that the pilots in the New Orleans crash made an error in taking off based on the information available to them.

[3] NTSB Press Release, May 1, 1976.

Ozark Airlines Fairchild Hiller FH-227B:

> Revise terminal air traffic control procedures to authorize controllers, when they deem an operational hazard is present, to deny (1) approach and landing clearances when thunderstorm activity exists over either the approach path or the airport, and (2) take off clearances when thunderstorm activity exists over either the airport or the departure path. (A-74-12).

The FAA refused to implement these recommendations on the grounds that: (1) "controllers are neither trained nor qualified to make this kind of judgment nor do they have the equipment to aid them in reaching this kind of decision"[4]; (2) "adverse winds associated with thunderstorm activities . . . may be widely separated from the actual observable thunderstorm activity [and] accordingly, runway selection on the basis of other than known winds actually affecting the runway in use could very easily result in operational conditions not acceptable by users . . ."[5]; (3) "air traffic control has no present effective means of assessing the current severity of thunderstorm activity or the area of airspace that may be affected."[6]

At the time the FAA refused to implement these recommendations, the LLWSAS had not been put into place at airports. Had it been in place, the FAA might have responded differently since the LLWSAS solves all the problems raised by the FAA. A controller does not have to be a meterologist to read the LLWSAS display, the LLWSAS display is based on actual known winds on the runway, and the LLWSAS provides the tower with information on the severity of the effects of the thunderstorm at the airport.

Closing runways based on LLWSAS alerts would be consistent with the original purpose of the system, which was allow pilots to avoid wind shear rather than adjust to fly through it. In explaining the FAA's wind shear research and development program in 1978, an FAA representative said: "The first objective is to warn the pilots, and I hope this conveys that we are looking for avoidance, not putting you in a situation but avoiding it before it occurs."[7]

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[4] Letter from Alexander P. Butterfield, Administrator, FAA to John H. Reed, Chairman, NTSB, April 30, 1974.

[5] Letter from John L. McLucas, Administrator, FAA to Honorable Webster B. Todd, Jr., Chairman, NTSB, July 7, 1976.

[6] Ibid.

[7] Statement of Guice Tinsley, FAA, at the Air Line Pilots Association Air Safety Workshop: "Windshear -- An Update," p.69, (June 20-22, 1978). (hereafter ALPA Workshop).

It would also be consistent with the original purpose of procedures that were developed by the FAA at the request of the National Transportation Safety Board for flying through wind shear. While these procedures are apparently now used for flying through known wind shears, their original purpose was for flying through inadvertent wind shear as can be seen in the following February 16, 1978 recommendation made by the NTSB after the Allegheny Airlines DC-9 wind shear accident at Philadelphia, Pennsylvania:

> Establish a joint Government-industry committee to develop flight techniques for coping with inadvertent encounters with severe wind shears at low altitude. (A-78-3)

(emphasis added). This original purpose can also be seen in another 1978 statement by an FAA spokesperson concerning the FAA's research and development program:

> I would like to say one thing, the FAA in no way is trying to teach pilots to fly their aircraft through hazardous conditions. That's not the name of the game. The name of the game is avoidance . . . [W]e also realize that if you inadvertently enter a hazardous condition, you also need the information to help you cope with it. We are really working in both ways. We are advocating avoidance not coping only.[8]

The wind shear alert system should be used to deny take-off clearances since it only sets off an alarm when the wind shear is 15 knots or greater thereby eliminating unimportant wind shear information.

The importance of a 15 knot wind shear has been recognized by Continental Airlines which tells its pilots not to fly when there is wind shear of 15 knots or more. According to a 1978 article by Continental Airlines in the Journal of Air Traffic Control:

> When the presence of wind shears in excess of 15 knots is suspected for departure, the pilot should delay takeoff until conditions are right. Most thunderstorm shear will transit a given location in a short time. An approximate guide would be to wait 30 minutes for wind shear that is building and 15 minutes for shear that is subsiding.[9]

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[8] Statement of Col. Larry Wood, FAA, at the ALPA Workshop, p.95.

[9] ACAP called Continental Airlines and was told that this is still their policy today.

The manufacturer of the Low Level Wind Shear Alert System, Sangamo Weston/Schlumberger also believes that a 15 knot wind shear is hazardous and recommends that the FAA "mandate that no aircraft lands or takes off within 15 minutes of an alert given by the LLWSAS system."[10] According to Sangamo Weston:

> It has been suggested that [this recommendation] would result in substantially increased delays to flight schedules during bad weather. There is little evidence that this would be very severe. Most traffic controllers report that it is rare to experience more than three or four alerts in the course of a week (usually all in one day or, in the south, all during a short period in the evening).[11]

Further evidence that a 15 knot wind shear is hazardous can be obtained by examining the manner in which the 15 knot threshold for alerts was developed by the FAA. ACAP asked the Program Manager for Aviation Weather Systems Developement at the FAA Technical Center in Atlantic City how the threshold was set and was told that the 15 knot threshold was originally derived in a non-aviation context as a result of research done at the National Severe Storms Laboratory (NOAA/DOC) at Norman, Oklahoma.[12] According to

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10 Memorandum on Flight 759, Attachment to letter from William E. Hardman, Sangamo Weston/Schlumberger, Industrial Systems, to Matthew Finucane, ACAP, July 26, 1982.

11 Ibid. According to Sangamo/Weston, the LLWSAS is already sometimes used to close airports:

> Quite frequently SWIMS [the LLWSAS] indicates shear conditions resulting in controller decisions to close airports temporarily.

Sangamo Industrial Systems: "SWIMS: Surface Wind Monitoring System", p.9 (August, 1981). According to William Hardman of Sangamo Weston, information on wind shear is conveyed from the tower to the airport manager who in turn closes the airport. ACAP has also been informed by former controllers that controllers sometimes make up reasons for delays if there is wind shear alert and pilots are preparing to take off.

12 Conversation between Matthew Finucane, ACAP, and R. Craig Goff, Program Manager, Aviation Weather Systems Development, FAA, July 26, 1982.

the Program Manager, detailed research into 20 thunderstorms during the early 1970's revealed that a 15 knot wind shear was what would normally be associated with a "severe thunderstorm gust front."[13] The 15 knot figure was later confirmed as appropriate for an aviation context because it was equivalent to the relationship between what pilots said was a hazardous wind change in knots per second, the average distance over which shear occurs, and the speed at which aircraft travel.[14]

Although it could be aruged that clearances for landings as well as take-offs should be denied if there is a wind shear alert, we are limiting our recommendation to take-offs since: a pilot who takes off with full thrust on the aircraft has less energy and altitude available to maneuver with than a pilot who is landing, who, among other things, can attempt to go around; staying on the ground presents little difficulty for a pilot relative to staying airborne; and this recommendation would prevent a New Orleans-type accident from occurring in the future which is our immediate concern.

We recognize that this recommendation is controversial insofar as it transfers authority from the pilots to the controllers. However, we note that the ultimate decision on whether to take-off will remain with the pilot outside of this limited, threshold situation.

We also recognize that there may be some difference of opinion as to whether a 15 knot wind shear is serious enough to keep an aircraft on the ground. If the Board determines that a higher value might be more appropriate, we note that the software which operates the LLWSAS can be reprogrammed to indicate both a 15 knot wind shear (as a warning) and a higher wind shear (as a prohibition). All that would be needed is an additional display in the tower. Pending such a reprogramming, though, we believe that take-offs should be prohibited based on the current 15 knot wind shear alarm. While such a utilization of the LLWSAS might lead to overutilization of the system in some cases, such an overutilization would be preferable to the present ad hoc airline by airline, pilot by pilot, case by case use of the system which invites underutilization of the LLWSAS.

Finally, we recognize that this proposal is hardly the final solution to the wind shear problem. As you know, the pilots and the Board have been pushing for both airborne and ground devices which will give a much more accurate picture of wind shear

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13 Ibid. ACAP was told that this data can be found in: R. Craig Goff, "Thunderstorm-Outflow Kinematics and Dynamics", NOAA Technical Memorandum ERL NSSL-75 (December, 1975). ACAP was told that a "severe" storm was not defined in the study, but could be estimated as at least a Level IV storm.

14 Ibid. Thus, an aircraft travelling at a high speed through a 15 knot shear occurring over one-half to two-thirds miles will experience a rate of change in knots per second that will make it difficult to fly. ACAP was told that this data can be found in the FAA Final Report on the LLWSAS, May, 1980, pp. 75-81.

including information about wind shear at altitude as well as farther down the approach and departure path. We believe that such devices, combined with clear-cut rules for avoiding shears detected by these devices, are needed immediately to prevent further wind shear accidents.

We hope that you will give this recommendation the earliest possible consideration. We are asking the Board to make this recommendation to the FAA after evaluation and perhaps modification because of its expertise in weather-related accidents, the similarity between this recommendation and previous Board recommendations, and the relationship of the recommendation to your current crash investigation.

Sincerely,

Matthew H. Finucane
Director

cc: All Members

AIR LINE PILOTS ASSOCIATION
1625 MASSACHUSETTS AVENUE, N.W. WASHINGTON, D.C. 20036

August 27, 1982

Mr. Scott Crossfield
Technical Consultant
Committee on Science and Technology
U.S. House of Representatives
Suite 2321
Rayburn House Office Building
Washington, DC 20515

Dear Mr. Crossfield:

Concerning wind shear, I would like to offer the following for the Congressional Record:

A very important element in the proper assessment of risks by pilots is the manner in which they are trained regarding wind shear.

Many pilots have been trained to believe they can fly under a downdraft without undue concern because the downdraft can't blow through the ground and there should be a cushion of air. However, it is impossible to fly through the base area, without going from an increasing headwind on first encounters, to a lesser rate of increasing headwind and finally to a strong increasing tailwind. The initial encounter creates a sort of cushion, but this rapidly changes to a strong adverse reaction which can exceed an aircraft's performance capability. In a fatal air carrier accident in 1973 (Ozark FH-227 at St. Louis), trees in the approach path were blown down, which required an estimated 70 mph horizontal wind. No commercial aircraft can survive such an encounter with an increasing tailwind close to the ground when in the landing configuration.

Most pilots are familiar with the tragic accident of an Eastern B-727 at New York in June 1975. Before that time, it was not generally conceded that wind shear could be fatal. Many hard landings and clipped tree tops were passed off as pilot error. Before that accident, though, ALPA had successfully defended pilots against certificate action in similar circumstances by presenting meteorological evidence of large downdrafts and arguing the adverse effect on aircraft performance when operating within the base area of a downdraft. An assumption of aircraft thrust level was required, though, to define the magnitude of the wind shear from available flight recorder data.

It wasn't until the Continental B-727 takeoff accident at Denver in August 1975 that convincing evidence of the magnitude of the shear effects from a downburst was available. For the first time there was no argument about the thrust level. Dr. Fernando Caracena, atmospheric physicist with the National Oceanic and Atmospheric Administration, presented a landmark study documenting the downburst's flow patterns from 14 surface anemometers, pressure plates from microbarographs and other evidence.

Even after the above-ment'oned accidents, there has been little emphasis on the problems associated with the base area of a downburst and pilots have not generally recognized the clues that indicate the presence of a downburst.

For example, just prior to the Allegheny DC-9 crash at Philadelphia in June of 1976, an Eastern flight had executed a missed approach because the pilot had experienced a large airspeed gain and could not get the aircraft on the ground in a reasonable distance -- the crew expressed their intent to make another approach which would seem to indicate that they did not understand that they had encountered outflow from a downburst. Had they appreciated the problem and delivered that information to the crew of the Allegheny DC-9, it is probable that the Allegheny crew would have aborted the approach. When Allegheny observed what appeared to be very strong crosswinds near the surface, they applied takeoff power, retracted the flaps to takeoff and attempted to go around. At this point, they entered the downburst which forced the airplane into the ground with a 10 G impact. Unquestionably, the decision to go around prevented a disastrous accident (there were no fatalities).

Unfortunately, the National Transportation Safety Board (NTSB) focused on the fact that the pilots had apparently not reset their Engine Pressure Ratio (EPR) bugs and could have deprived themselves of .04 EPR per engine, a relatively small amount of power. In the simulator tests, Douglas Aircraft produced a wind shear that could just barely be flown through at the proper EPR value and with maximum energy trade into ground effect. However, Douglas did not claim that this simulation was representative of the actual shear encountered by the Allegheny crew.

The NTSB report stated, "...however, if the aircraft's full aerodynamic and power capability had been used, the wind shear could probably have been flown through successfully." It is very contradictory to establish a 10 G impact and make the above allegation with no more evidence than presented. Considering this accident occurred with a twin engine aircraft loaded well below its maximum operating weight for the condition, which means its climb performance was in the upper range of all commercial jet aircraft, the NTSB statement would appear to be most unrealistic. One of the biggest problems in educating pilots to the dangers of wind shear has been the "if he had done such and such, he would have made it" comments which merely invite all other pilots to try their skill at making it through a downburst.

A dissenting opinion by Philip Hogue, member of the NTSB, states, "...by the time the captain knew he was experiencing wind shear, it was too late to avoid it and had he known the true conditions at the time of his final approach, he would have aborted his approach earlier. Further, I do not concur that 'if the aircraft's full aerodynamic and power capability had been used, the wind shear could probably have been flown through successfully.' The foregoing statement, based on one simulation, is speculative, and will remain so until standard operating procedures for dealing with various degrees of wind shear are proven in the real world under actual conditions."

The real lessons to be learned from this accident are (1) pilots should be educated to the clues of a downburst, and (2) the early decision to execute a missed approach can save the lives of many passengers.

In June of 1977, a Continental B-727 experienced a takeoff accident at Tucson. In this case the pilot passed through the gust front while taxiing out and took position for takeoff with a strong wind right down the runway. Again though, the pilots did not recognize the clues of a downburst and they took off headed right toward the base area of one. As the aircraft climbed into the base area, it encountered a strong increasing tailwind and began to descend. It hit a power line and then experienced a dramatic increase in airspeed which enabled a go around. Dr. Caracena told the NTSB staff that this increase in airspeed was a result of penetrating the gust front.

The NTSB report though ignores Dr. Caracena's presentation and states that the increase in airspeed at the power pole was because the captain "...lowered the pitch attitude before hitting the powerlines." Again the NTSB chose to argue some magic way to fly through a wind shear "...if the aircraft's full aerodynamic capability had been used." The actual airspeed gain at the impact point was 27 knots over a one second interval, a rate which can not be accounted for by an assumption of aircraft rotation.

Caracena also said that if the takeoff had been delayed by three minutes, the aircraft would have crashed before it could have penetrated the gust front.

There is no magic way to fly through a severe wind shear. However, best aircraft performance occurs when the aircraft is operated at the best angle of climb speed which occurs at the point where available thrust exceeds drag by the largest margin. The best angle of climb speed occurs at the minimum drag point for jet aircraft, but for propeller driven aircraft it occurs at a speed below the minimum drag point because of the large increase in propeller thrust as speed decreases. The most adverse effect of wind shear upon aircraft performance occurs due to the rate of encounter of the shear. The excess of available thrust over drag is what can give the inertial acceleration required to counteract this effect. Obviously, if an aircraft is operating above the best angle of climb speed, a very beneficial energy trade can be made to gain altitude, but there is a limit to how much the speed should be allowed to decrease. Not only does the drag increase significantly at speeds below the best angle of climb speed, but every pilot knows he must keep enough energy in the aircraft to successfully flare in the event he is forced into the ground.

Some wind shear models used in simulators were constructed so that a gain in altitude would get the aircraft out of the shear condition. Dr. Joe Tymczyszn, FAA flight technical programs staff, stated at the Air Line Pilots Association Air Safety Workshop in June 1978, "With respect to simulator training there is a problem area. If the simulator can only be programmed to vary windshear as a function of altitude instead of the way it is in the real world where, in the thunderstorm, the wind will vary as a function of altitude and distance that you have traveled forward, then you have a problem. The energy trade will look like a wonderful solution under that situation because if you get into a wind shear and all of a sudden you pull hard and just for a second you can stop the altitude loss and hold your altitude, then with that programming of the simulator there will be no more windshear. You will magically stop the windshear by holding your altitude.... If you train under those circumstances, it would be bad training, because it would teach you to pull hard and the windshear magically goes away."

If a pilot is in a wind shear and knows the limits of the shear that is fine, but he isn't going to know these limits and he must reserve some energy to minimize ground impact if it becomes inevitable. Some advisors, though, would have a pilot use all available energy in an attempt to get out of the shear. This creates a special hazard in the approach situation since one of the most important performance benefits occurs when the flaps are partially retracted for a missed approach. Obviously, if the speed has been decreased to where the flaps can't be safely retracted, this benefit cannot be used.

Although a speed less than best angle of climb can be flown, it is best to limit the airspeed loss to one that still leaves some margin to flare. So far this limit has not been established. Tests have not been conducted where a crash was certain and minimizing ground impact was required.

The above factors were considered at the Fifth Annual Workshop on "Meteorological and Environmental Input to Aviation Systems" at the University of Tennessee Space Institute, March 3-April 2, 1981. In the report of the Operational Procedures Relative to Severe Weather Committee (NASA Report CP-2192, p. 105), Chairman Dr. Fernando Caracena stated,

> "Wind Shear
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> "There was a great deal of interest in the topic of wind shear; how a pilot should manage it; what is the proper pilot training procedure, the need for a good terminology, and the role of heavy rain in wind shear accidents.
>
> "The committee recommends that in a wind shear encounter a pilot should use the optimal performance configuration for his aircraft; and not try to fly aircraft out on the "stick-shaker" as has been suggested in the past. The attempt to maintain altitude in the face of rapidly deteriorating airspeed is a dangerous procedure that could end in disaster.

"Perhaps the "stick-shaker" procedure has evolved from a misinterpretation of the character of thunderstorm wind shear. The aircraft industry first recognized the wind shear hazard in an accident involving a frontal type shear. Across a frontal inversion, winds that are almost horizontally homogeneous change rapidly with height. An aircraft descending or ascending through the frontal inversion experiences rapid changes in the airspeed. Its rate of encounter with the wind shear is proportional to its vertical velocity. If the aircraft's rate of descent or ascent is arrested, then the effects of the shear disappear. Flight simulators containing this type of shear give a clear but misleading message: arrest the rate of descent or ascent of the aircraft and the effects of the wind shear disappears. Unfortunately, in a thunderstorm situation that doesn't happen because of strong horizontal wind shear components.

"In a thunderstorm the winds are far from being horizontally homogenous. Downdrafts produce strongly diverging surface winds. As an aircraft flies across the base of a strong downdraft, strong headwinds may rapidly switch around to become a strong tailwind. In this case, the rate of encounter with the windshear is proportional to an aircraft's horizontal motion, and arresting an aircraft's rate of descent is not going to alleviate the rapid loss in air speed. Only a complete stopping of the aircraft's horizontal motion will arrest the aircraft's encounter with this type of shear. Therefore, the "stick-shaker" procedure that might be applicable to encounters with frontal type shear is inappropriate and dangerous in a thunderstorm wind shear encounter.

"Wind shear training programs and terminology

"A deficiency in wind shear training programs came to the attention of the committee. Some flight simulator profiles are deliberately designed so that it is just barely possible to successfully penetrate the wind shear. This tends to create the false impression on trainees that any wind shear can be penetrated by using the correct techniques. Past research shows that there are some wind shears so severe that no commercial aircraft is going to be able to successfully penetrate them. In this case, the best procedure is one that results in the softest impact. The upcoming JAWS project may shed additional light on the degrees of wind shear severity that are likely in downbursts and microbursts.

"The committee discussed the need to develop a clear non-technical presentation of wind shear for pilot training. Along with this, there is a clear need to develop an ICAO standard terminology for describing the effects of wind shear on flight performance. At present, aeronautical engineers, meteorologists and pilots have different terminologies for wind shear which is an additional source of confusion.

"Wind shear and heavy rains

"More research needs to be done on the effect of heavy rain on flight performance. There is no doubt that heavy rain or high liquid water content in the atmosphere will degrade the flight performance of an aircraft. Current research on the subject, however, does not give a good estimate of how large the effect may have been in a number of recent accidents that have been attributed to wind shear. Certainly, research results at the present do not justify headlines to the effect that heavy rain and not wind shear may have been the actual cause of these accidents.

"Let us remember that there were direct indications of strong wind shears during several of the accidents in question. At J. F. Kennedy International Airport, a number of aircraft were affected by strong cross winds as well as headwinds and tailwinds before the crash of Eastern Flight 66. Heavy rain which may simulate changes in the headwind component cannot simulate strong cross winds. Also the presence of strong cross winds implies strong longitudinal components of wind as well since these winds were driven by thunderstorm downdrafts. At Philadelphia International Airport, the aircraft attempting to land ahead of Allegheny Flight 121 encountered such strong headwinds that the pilot could not force the aircraft down to the end of the runway and for this reason elected to go-around. Eyewitnesses at the surface reported strong winds as well as heavy rain. When Allegheny Flight 121 was on the approach, the cell that had caused the strong headwinds previously had now moved to the edge of the runway. After flying under this cell, the aircraft crashed because the strong headwinds that it was experiencing suddenly disappeared. Thus, in both Eastern 66 and Allegheny 121 accidents, there were strong wind shears as well as heavy rain. We know that the wind shears were strong enough to cause other aircraft problems even when these aircraft were not directly affected by heavy rain.

"A detailed investigation of wind shear accidents shows that there have been wind shears strong enough to crash airplanes without any help from heavy rains. At Denver, Continental Flight 426 was downed by a thunderstorm that produced only very light rain. At Tucson, a dry thunderstorm produced strong winds, blowing dust, and only a light sprinkle, and yet in each case the wind shear generated was strong enough to cause an accident.

"The importance of heavy rain is not that it may be the "only real villain" in wind shear accidents, but that it produces an effect in the same direction as that of the wind shear. Heavy rain is likely to be found in association with a strong downdraft. Its presence worsens the performance of the aircraft, and the combined effect of heavy rain and wind shear may be to make it virtually impossible for an aircraft to survive the encounter.

"X-Band Vs. C-Band radars

"The committee discussed the problems associated with present airborne radars. Most commercial aircraft use X-band radars. It is known that X-band radars have severe attenuation problems that tend to distort the radar presentation of severe thunderstorms. This can lead a pilot to be dangerously mislead about the structure of a storm that he may be trying to navigate around. This problem can be alleviated to some extent by having commercial airlines switch to the use of C-band radars. At present one of the major airlines uses the C-band radars. In general, the longer the radar wavelength, the less is the problem of attenuation; however, size requirements for the radar antenna limits the practical range of wavelengths for airborne radars in commercial aircraft. Incidently, pilots should be made aware of radar attenuation due to wet radomes. Attenuation due to a wet radome results in a deceptively weak radar return. This is true of both C-band and X-band radars.

"While the use of a 10 cm radar such as is available from a WSR-57 would be very valuable to the pilot, it would be far from practical to mount one in an airliner. However, the radar presenation of a ground based WSR-57 could be made available to the cockpit by means of a data link system.

"Data Link System

"As in past sessions, our committee recommends the implementation of a data link system. The ACAR data link system now being planned could become a means for gathering meteorological data from aircraft in flight. After processing on a central computer, this data could become the basis for continually upgrading forecasts which in turn could be uplinked back to aircraft in flight. In addition, other meteorological data such as WSR-57 radar scope presentations could also be relayed to the cockpit to augment the aircraft's own radar. The use of a larger area radar presentation with minimum attenuation would be an important supplement to aircraft's own radar."

In almost all wind shear related accidents and incidents there was evidence before the event that in retrospect should have prevented the accident/incident if the evidence had been collected and disseminated in a timely manner to the flight crews and if the flight crews had recognized the risks involved. According to the above rationale, ALPA is proposing for discussion a system to rate the wind shear risks for various meteorological conditions which could limit the highest risk operations while not imposing an undue economic burden upon operators such that the limits would be ignored.

What is proposed is to establish levels of risks along the following lines:

LEVEL 1. Meteorological conditions not conducive to wind shear. Basically clear and nearly calm winds--5 knots or less. This level would not be transmitted to pilots unless there was a pilot request for the wind shear level.

LEVEL 2. Some wind shears. Surface winds from 5 to 20 knots. Orographic shears, nocturnal jet stream, general gustiness. Well within capability of aircraft performance. There would probably be some wind shears reported at this level. Level 2 would not be transmitted unless there was a report of a wind shear and then only to inform pilots that the risks of encountering a shear that would exceed their aircraft performance would be very small.

LEVEL 3. Surface winds 20 to 40 knots. Wind shears approaching limit of 1 knot per second in horizontal plane. Greater than 10 knot variations in airspeed reported by pilots. Shears associated with frontal conditions. Although these shears are within the capability of aircraft performance, they can be hazardous if not immediately identified and corrected for. Level 3 and subsequent levels should be transmitted on the ATIS and given as advisory information by the tower.

LEVEL 4. Wind shears beyond the capability of jet transport aircraft to correct for without an energy trade are a possibility. Vertical development of clouds with cell activity within 10 nm of an airport. Reasonable expectation of a downburst or microburst. Excess energy recommended for all aircraft. At this level all persons should be keenly tuned to search for further evidence which would confirm the presence of a microburst or downburst. Surface winds in excess of 40 knots should also be classified as Level 4 because there is a high probability that orographic shears could exceed aircraft performance capability.

LEVEL 5. Vertical development with presence of microbursts or downbursts confirmed by (1) ground instrumentation, (2) aircraft instrumentation, (3) aircraft encounter (missed approach, hard landing, etc.), (4) visual sighting (ring of dust, etc.), (5) other information. Level 5 should be automatically assigned if a cell is within 5 nm of the airport unless the airport has an approved ground detection system that is capable of identifying microbursts, in which case operation could be continued as long as arriving and departing aircraft could remain more than 3 nm from any cell while below 1,000 feet agl. At Level 5 operations should be suspended until observations indicate the level can be downgraded to 4.

No prudent pilot should attempt to takeoff or land at Level 5 unless other risks are predominant, such as low fuel state, etc.

The assignment of the levels 1 through 4 should be done by a meteorologist. Level 5 would be automatic if any source of information indicated the presence of a microburst or downburst.

Consideration should be given to an automatic "Wind Shear Alert--Level 5" transmitted on tower frequency when Level 4 has been assigned and ground instrumentation confirms the presence of microbursts/downbursts or if an air traffic controller activates the automatic transmission. "Wind Shear Alert" should not be transmitted to pilots just because the alert system in the tower alerts the controllers to the fact that there is a 15 knot variation in wind. In this case, the actual wind values should be transmitted to pilots. A higher value than 15 knots should be used for an automatic alert. Otherwise pilots will tend to ignore the warnings as they will occur frequently when they do not indicate the presence of a microburst or downburst.

An automatic alert feature could possibly be transmitted to ACARS for transmission by data link to all aircraft so equipped in the area. ACARS could activate a voice alert in the cockpit.

In addition, the FAA should examine the flight training in wind shear procedures of all airlines to ensure that (1) pilots are not being taught to be overly confident of their abilities to fly through severe wind shear, (2) stick shaker techniques are not being taught as a means to penetrate severe wind shear, or (3) special procedures for take off in severe wind shear are only being advised if a pilot has already taken off when he is alerted to a wind shear hazard.

There should be an industry meeting of experts to discuss the parameters for the suggested risk levels. ALPA suggests such a meeting be conducted by Dr. Walter Frost of the University of Tennessee Space Institute, who in addition to being a leading expert in the field of wind shear effects upon aircraft, conducts a regular meeting of experts in this area as a "Workshop on Meteorological and Environmental Inputs to Aviation Systems", which is supported by NASA, FAA and NOAA.

The stick shaker is installed on most jet aircraft to warn of the impending danger of adverse aerodynamic characteristics at very high angles of attack. They are not calibrated and maintained as a flight instrument and can not be used as such, although the information that drives the stick shaker, an angle of attack sensor, could provide pilots with the most useful information to optimize performance if incorporated into an angle of attack display.

Pitot tubes generally have large calibration errors at high angles of attack such that at only a small indicated airspeed loss below the stick shaker, there is actually a large decrease in calibrated airspeed. For example, one commercial jet aircraft has a stall speed of 95 knots (calibrated airspeed) at a representative landing weight. At 102 knots of indicated airspeed the calibrated airspeed is equal to 102 knots, but at the stall speed of 95 knots,calibrated, the indicated airspeed is 100 knots. Thus, for only a 2 knot variation in indicated airspeed below the approximate point of stick shaker, there is actually a 7 knot decrease in airspeed at which the aircraft is in a stall. Most commercial jet aircraft were actually at high descent rates at the certified stall speed due to an interpretation of the certification regulation which allows a speed less than the 1G mil spec stall.

The effect of heavy rain upon an airfoil is to reduce the maximum lift coefficient thus increasing the real stall speed, making it extremely dangerous to attempt to fly on the stick shaker in heavy rain.

A complicating factor in risk assessment is that the FAA treats identifiable human error as criminal negligence, thus making it impossible for them to adequately fault monitor the aviation system. Pilots are most reluctant to tell of cases where they almost crashed, but risk assessment to prevent accidents depends on accurate knowledge of all of the free looks at fate that did not result in an accident. The FAA is not doing its job of fault monitoring the aviation system and can not accomplish this task without a more mature attitude of dealing with errors.

Finally, the greatest single impediment to accident investigation and improving safety is the fear of litigation. In one recent accident, the claims will possibly settle for more than the combined profit of the entire airline industry over a ten year period.

I do not intend to argue against some award for wrongful death. But, there has to be a reasonable limit. If a person's life is worth $5 million dollars, he should make an attempt to insure it for that amount in case he happens to die riding a bicycle or is hit by a meteorite instead of being killed in an airplane crash. Although commercial aviation is the safest form of travel, by far, it can not remain as a viable, safe service with outrageous damage awards for wrongful death. The advance of safety is dependent upon open and frank disclosure of all of the facts relative to an accident which can not happen under the present threat of damage awards.

Sincerely,

Bill Melvin

William W. Melvin
Chairman
Airworthiness and Performance Committee

STATEMENT OF LAWRENCE C. CUSHING, PRESIDENT, NATIONAL ASSOCIATION OF AIR TRAFFIC SPECIALISTS

Mr. Chairman and Members of this Subcommittee, I deeply appreciate the opportunity to appear before you and to testify on the impact of weather on aviation safety. I am Lawrence C. Cushing, President of this Association.

This Association is grateful that you have chosen this subject and have scheduled these hearings. In our view the greatest area where aviation safety can be enhanced is in the area of getting timely and accurate weather information to the ultimate user, the pilot. He is the one who controls the aircraft and he is the only one who can take timely action to change course, change speed or change altitude to avoid hazardous weather.

This Association is an independent labor union which represents air traffic control specialists/station. They are federal employees of the Federal Aviation Administration and work at flight service stations. Other air traffic control specialists/center/tower also work for the Federal Aviation Administration and they are without representation by a labor union at this time.

There are approximately 300 flight service stations throughout the United States and their specific functions are set forth in Attachment (1) (FAA Budget Justifications for Fiscal Year 1982). You will note from that attachment that the primary functions are: (1) the provision of flight assistance service (preflight, inflight, and emergency) and (2) the collection and distribution of meteorological and aeronautical information.

The National Weather Service has been called the "wholesaler" of weather information and the flight service system has been called the "retailer" of *aviation* weather information.

This Committee is commended for concerning itself with the specifics, the why's and wherefore's of the entire system which leads to inadequacy in aviation weather observations, in aviation weather forecasting and in the dissemination of the necessary aviation weather information to the ultimate users, the pilots of this nation's aircraft.

It is a matter of record that the flight service system is the primary source of weather observations for the specific use of the nation's air traffic system and one of the primary sources of meteorological data for the National Weather Service. In fact, the House Appropriations Committee in its report on the 1983 Transportation Bill suggests that the Department of Commerce reimburse the FAA for its weather collection activities. The material we provide is used by the National Weather Service in preparing the terminal (specific location) and area (general geographic area) weather forecasts which aviation interests rely upon for flight planning purposes. It is also used in the preparation of Airmens Meteorological Advisories (AIRMETS) and Significant Meteorological Advisories (SIGMETS) which pilots rely upon as a means of avoiding flight into extremely hazardous meteorological conditions. Failure to provide such available information (SIGMETS) is cited as a causative factor in two air carrier accidents. It is noted that about 35 percent of air carrier accidents are weather related and that 40 percent of all general aviation accidents are also weather related.

Since the relationship of the flight service system to the

aviation weather picture and to the efforts of the National Weather Service is germane to this issue, the deficiencies of the flight service system are also germane to the issue.

During the past two or three decades the Federal Aviation Administration has dedicated the preponderance of its resources to the safety of scheduled air carriers (centers and towers) and only a paucity of resources to the safety of general aviation and to the distribution of weather information (flight service system).

While there are about 300 flight service stations, 99 percent of them are using equipment dating back to World War II or earlier and the buildings themselves are of similar vintage and condition.

Three stations have been partially modernized on an experimental basis and they are located at Leesburg, Virginia, Atlanta, Georgia and Indianapolis, Indiana. These three stations have a remarkable capability but even so are unable to meet the demands placed upon them for weather and safety information.

The genesis of the flight service system modernization or automation program and the status of that program has been addressed to other Subcommittees and will not be addressed here. Suffice it to say, the flight service system, by deliberate design, is and has been chronically understaffed and the equipment in general use is woefully inadequate and is not presently capable of providing adequate or timely service to a majority of those who desperately need the services we should but cannot provide. Since the flight service system is an integral and vital part of the aviation

weather gathering and dissemination network, it should be obvious that flight service deficiency relates instantly and dramatically to the degradation of aviation safety.

Recognizing the unwise policies of the FAA in its proposals to reduce hours of service and to close flight service stations, the Congress itself took action to preserve this weather collection and dissemination system. This wisdom of the Congress is contained in Section 528, Title V of the Tax Equity and Fiscal Responsibility Act of 1982, which is quoted as follows:

> "SEC. 528. PART-TIME OPERATION OF FLIGHT SERVICE STATIONS.
> (a) Beginning on the date of enactment of this title, the Secretary shall not close or operate on a part-time basis any flight service station except in accordance with this section.
> (b) During the period beginning on the date of enactment of this title and ending on September 30, 1983, the Secretary may provide for the part-time operation of not more than sixty existing flight service stations operated by the Federal Aviation Administration. The operation of a flight service station on a part-time basis shall be subject to the condition that during any period when a flight service station is part-timed, the service provided to airmen with respect to information relating to temperature, dewpoint, barometric pressure, ceiling, visibility, and wind direction and velocity for the area served by such station shall be as good as or better than the service provided when the station is open, and all such service shall be provided either by mechanical device or by contract with another party.
> (c) The Secretary may close not more than five existing flight service stations before October 1, 1983. After October 1, 1983, the Secretary may close additional flight service stations, but only if the service provided to airmen after the closure of such station with respect to information relating to temperature, dewpoint, barometric pressure, ceiling, visibility, and wind direction and velocity for the area served by such station is as good as or better than the service provided when the station was open and such service is provided either by mechanical device or by contract with another party."

Obviously, stern action is required to cause the FAA to recognize

its responsibilities to provide timely weather information to the users.

Following the weather related crash of a Southern Airways aircraft at New Hope, Georgia in 1977, the FAA responded with a typical knee-jerk reaction. Completely ignoring the professional weather capability already available in the flight service system, the FAA established an entirely new and completely unnecessary weather capability, the Center Weather Service Unit, at enroute air traffic control centers. Since the inception of that program there have been at least two more commercial aviation accidents, involving fatalities, which are directly related to deficiencies in the Center Weather Service Unit program. The primary duty of air traffic control specialists assigned to the air route traffic control centers is air traffic control. One of the primary duties of air traffic control specialists at flight service stations is aviation weather. The logical place for the Center Weather Service Unit capability is at the enroute flight advisory position at flight service stations. Instead of a massive, tremendously expensive and time consuming new effort, the flight service station capability could have been expanded and improved almost overnight to provide a superior product at far less expense.

There are also other factors which will adversely affect the aviation weather picture. Because of economies imposed by the new Administration, the National Weather Service has decided to close many of its aviation weather terminal forecast locations

and to consolidate its activities at centralized locations. The forecasters being removed are those who, up to now, have concerned themselves with aviation weather. This decision need not be totally adverse if immediate action is taken to alleviate the situation. The remedy in this case once again exists at the flight service stations. Flight service station specialists are already highly trained in weather observing and in interpreting all aspects of weather forecasts for pilot weather briefing purposes. A little additional training could provide a large cadre of specialists qualified to update or to amend the forecast material provided by the National Weather Service. The flight service specialist could easily provide all other air traffic control interests with all available meteorological information as a means of avoiding repetition of the New Hope, Georgia and other weather related accidents.

Mr. Chairman, what was needed both prior to and following the New Hope, Georgia fatal accident was a completely cooperative effort from all air traffic system components. I regret to say that lack of that cooperation was at least partly responsible for the New Hope Southern Airways crash and I regret to say that no action has been taken by the FAA to remedy that sad situation. As an indication of our concern, I contacted the National Transportation Safety Board, following the New Hope crash, and I have attached (as Attachment 2) copies of that correspondence. That correspondence stands as an indictment of the FAA's stewardship in this matter since they have done absolutely nothing to correct the deficiencies noted.

It is inconceivable to this Association that there is no requirement for emergency coordination among flight service stations, enroute centers and towers. One would think that just the opposite would be true and that all resources, both public and private, would be brought to bear to obviate such a tragedy.

Mr. Chairman, this concludes my statement. I would be pleased to answer any questions directed to me.

Attachment (1)

OPERATIONS

Operation of Traffic Control System

Flight Service Stations

	1981 Estimate	1982 Estimate	Difference
Permanent Positions	5,068	5,068	-0-
Personnel Compensation and Benefits	$156,759,000	$160,104,000	+$3,345,000
Other Costs	3,363,000	3,771,000	+ 408,000
Total	$160,122,000	$163,875,000	+$3,753,000

The flight service station portion of the air traffic control system consists of an extensive network of landline teletypewriter circuits, point-to-point radio circuits, air-ground radio channels and related equipment for the exchange of air traffic control information, and for flight assistance services.

The primary functions of the flight service station system are: (1) the provision of flight assistance service (pre-flight, in-flight and emergency) and (2) the collection and distribution of meteorological and aeronautical information. Flight service stations provide pilot weather briefings and flight planning services to all categories of civil aviation. Briefings are provided individually by radio, telephone, and in person and collectively by broadcasts, transcribed broadcasts and recorded telephone messages. All VFR flight plans are handled by the flight service station system. IFR flight plans are received by flight service stations and transmitted to air route traffic control centers. Flight service stations also operate the military flight service system, sending flight notification messages to the destination base operations office for all itinerant military flights. In an average year, flight service stations execute about 3,000 emergency flight assists. Flight service stations also take approximately half of the nation's first order civil weather observations, and operate the aviation weather telecommunications system. Observations are collected and relayed over teletypewriter service A to National Weather Service offices and to private subscribers. Additionally, National Weather Service products (forecasts, summaries, warning and advisories) are relayed to all subscribers.

In addition to their primary functions, flight service stations relay air traffic clearances to aircraft arriving and departing from airports which are without control towers; provide airport advisory service (wind, altimeter and traffic information) at airports without control towers or when the control tower is not in operation; relay special VFR clearances; monitor most enroute navigational aids; operate the notice to airmen system, operate the alerting system for search and rescue with respect to VFR flights; operate special reporting services in hazardous areas (island, lake, mountain, ocean and swamp reporting services); provide transborder and Customs notification services, relay administrative messages; and administer airmen examinations.

Attachment (2)

NAATS

NATIONAL ASSOCIATION OF AIR TRAFFIC SPECIALISTS

SUITE 415 WHEATON PLAZA NORTH
WHEATON, MARYLAND 20902

July 13, 1977

Area Code 301
946-0963

Mr. Webster B. Todd, Jr.
Chairman
National Transportation Safety Board
800 Independence Ave., S.W.
Washington, D.C. 20594

Dear Mr. Todd:

Questions have been posed to me concerning the crash and investigation into the crash of Southern Airways Flight 242 on April 4, 1977 on Georgia State Road 92.

According to information received, after emergency conditions were experienced by Flight 242, the aircraft was at one time very close to the Carterville Airport and at another time very close to the Cedartown Airport either of which would have been suitable for emergency landing; apparently no attempt was made to land at either.

Both Carterville Airport and Cedartown Airport are in the 100 mile area of responsibility covered by the Atlanta, Georgia Flight Service Station and it is a mandatory requirement that all pertinent information concerning those airports be known by or immediately available to all Full Performance Level Flight Service Specialists employed at the Atlanta Flight Service Station.

The question(s) posed are as follows:

Was any attempt made to contact the Atlanta Flight Service to obtain available information on the Carterville and Cedartown Airports and to make such information available to the pilot(s) of Southern Airway Flight 242?

Is there any current FAA requirement for coordination of emergency actions between the three integral parts of the Air Traffic Control system - stations, centers and towers?

If there is not such requirement, should there be?

As an interested user of the system it appears very possible to me that valuable, pertinent, readily available and possibly life saving information was not made available to Flight 242 and that the subsequent crash might therefore be considered as a "system failure" in addition to whatever other decisions are reached.

Your response and comments will be appreciated.

Sincerely,

Lawrence C. Cushing

Lawrence C. Cushing
President & Executive Director

On August 8, 1977 the Chairman responded:

National Transportation
Safety Board

Washington, D.C. 20594

Office of
Chairman

August 8, 1977

Mr. Lawrence C. Cushing
President & Executive Director
National Association of Air Traffic Specialists
Suite 413 Wheaton Plaza North
Wheaton, Maryland 20902

Dear Mr. Cushing:

This is in response to your letter of July 13, 1977, regarding the Southern Airways, Flight 242, accident which occurred near New Hope, Georgia, on April 4, 1977. The questions you raised are most pertinent to the investigation into the subject accident.

The record of the investigation does not indicate that any attempt was made by Atlanta Approach Control to contact Atlanta Flight Service regarding Cartersville and Cedartown Airports. The controller involved testified that he was not aware of "Cornelius Moore" (Cedartown Airport). The information regarding Cartersville Airport was made available to Southern Flight 242.

There are presently no specific requirements in the Federal Aviation Administration's Air Traffic Control Manual for coordination of emergency actions between flight service stations, centers and towers. Emergency actions are left to the discretion of the controller involved in handling the emergency. Since the fact-finding phases of the investigation have not been completed at this time, all possible areas of corrective action have not been finalized.

By copy of this letter we have instructed our Public Inquiries Section to forward to you a copy of the official accident report as soon as it is completed. This report will contain all facts relative to the accident, probable cause, analyses, conclusions and recommendations.

We appreciate your interest in this matter.

Sincerely yours,

for Francis H. McAdams

Webster B. Todd, Jr.
Chairman

Technical Report

on

Infrared Airborne Wind Shear Prediction System

Project: Aries (Airborne Radiometric Identification of Environmental Shear)

TO: A. Scott Crossfield
Technical Consultant
U.S. House of Representatives
Subcommittee on Science & Technology
Washington, D.C.

FROM: Peter M. Kuhn
Senior Research Scientist
Northrop Services, Inc.
315 Bellevue Dr.
Boulder, Colorado 80302

DATE: 20 September 1982

NORTHROP SERVICES, INC.

ABSTRACT

Wind Shear has been listed as causal by the National Transportation Safety Board in several air carrier accidents. In this connection, recent history again underscores the need for in-cockpit alerts of wind shear for take-offs and landings. The 13-15 micrometer position of the CO_2 molecular spectrum sensing atmospheric temperature at various distances ahead of an aircraft on approach or departure can be used to remotely sense low level wind shear (LLWS) in and around thunderstorms and gust front conditions. This is possible since there is a direct relation between the peak gusts in gust fronts and thunderstorm outflow and the drop in temperature from the ambient non-sheared environment to the gust front or thunderstorm environment. The proposed radiometer system senses this difference well ahead of penetration. An infrared band radiometer with several designed forward look distances of from 3.2 km (2.0 miles) to 10.0 km (6.25 miles) senses an average air temperature along a forward horizontal path. Infrared (IR) wind shear alerts are based on the difference between this forward air temperature and the static air temperature at the aircraft, keeping in mind that sudden or rapid cooling ahead is indicative of thunderstorm and/or gust front outflow and resulting wind shear. In fact, warm downburst and resulting outflow is also detected. Finally, IR spectral ranging for LLWS range identification either in an airborne or ground mode is at present feasible with cooled and non-cooled detectors. Included in this report will be sections on the Atmospheric Physics of Low Level

Wind Shear; Radiation Physics Applied to Instrument Design and Operation; Preliminary Airborne LLWS IR Radiometer Tests; and Operational Testing of the Final Prototype Requirements.

ATMOSPHERIC PHYSICS OF LOW LEVEL WIND SHEAR

Low-level wind shear (LLWS) is defined as wind shear occurring between the surface and 490 meters (1500 feet) above ground level. Wind shear is any change in wind speed and/or direction through a shallow layer of the atmosphere. The length and breadth range from 7 to 8 kilometers to 25 to 30 kilometers, while the vertical reach is in the hundreds of meters.

The meteorological phenomena producing low-level wind shear are, primarily, thunderstorm gust fronts (Fujita, 1976), fast-moving frontal zones, land-sea breeze phenomena, on occasion mountain waves, and less frequently, low-level inversions. In all cases, when it is detected it is usually after the fact. A typical aircraft approach into gust front conditions is depicted in Figure 1.

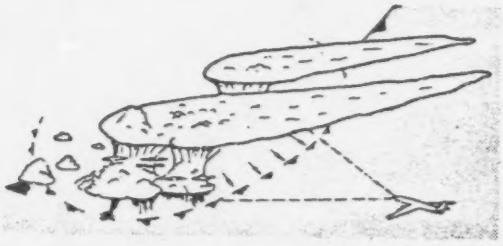

Fig. 1 Aircraft approach into gust front (after Fujita, 1976).

Low-level wind shear may be defined as positive or negative. Positive shear occurs in a flight track from a following or tailwind to a headwind while negative shear occurs in flight from a headwind into a tailwind region.

Negative buoyancy, the driving force in the downdraft producing a gust front, originates from the cooling of the subsiding air principally through evaporation of percipitation. As the downdraft approaches the surface it decelerates to zero as energy trades between the vertical and horizontal components of the downdraft. As the downdraft spreads out along the surface, horizontal components of velocity approach a maximum. Thus, it is shown that the temperature deficit of the downdraft is a good indicator of its strength and the horizontal wind resulting in shear behind the gust front.

Behind the gust front the cool horizontal outflow current can develop a strong vertical shear near the surface. The severity of this vertical shear increases with the magnitude of the temperature drop or deficit across the gust front. By remotely sensing the temperature deficit it therefore is possible to infer the probable strength of the vertical wind shear behind the gust front, and above a certain threshold, indicate a warning (Caracena & Kuhn, 1978). *An indicator found to be acceptable in the identification of a warning is the change in temperature sensed, $\Delta T(^{\circ}C)$, forward IR radiometer sensed air temperature minus the static air temperature at the aircraft observed over a unit time Δt.*

The meteorological basis for wind shear alerts is the relation of Fawbush and Miller (1954) which is depicted in Figure 2. This relation shows that the colder the downdraft the higher is likely to be the scale of the outflow wind. Since the relation of the wind to the wind shear generated is geometrical, the scale of the wind shear (as measured by surface divergence) also increases with the size of the negative temperature perturbation of the downdraft. The lower threshold for severe wind shear corresponds to a negative temperature perturbation of about 4°C.

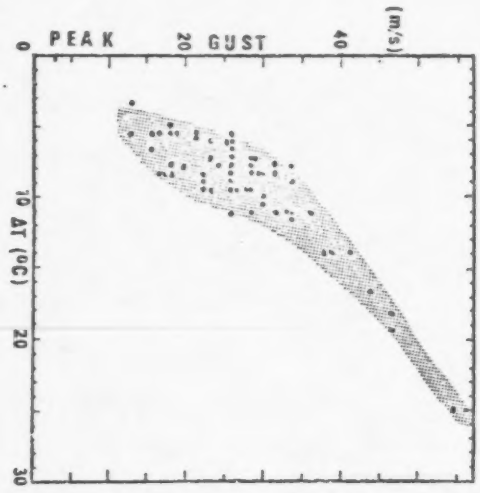

Fig. 2 Relation between the peak gust in the outflow and the drop in surface temperature from the thunderstorm environment to the base of the downdraft. Adapted from Fawbush and Miller (1954).

Fujita (1976) estimates that a ΔT of 4C to 9C can result in hazardous gust front damage. At the upper end of this scale wind damage to property and vegetation begins to mount.

Numerous studies show that vertical currents at a gust front are usually not too extreme. Updrafts generally do not exceed 10 ms^{-1} within the first 500 m (1525 ft) above the surface. However, the gust front is a region of strong horizontal and vertical wind shear (Goff, 1975).

RADIATION PHYSICS APPLIED TO INSTRUMENT DESIGN

An airborne infrared radiometer system sensing air temperature in one or more bands of the 13-16 micrometer portion of the carbon dioxide spectrum is designed to provide in-flight predictions or wind shear alerts based on remotely sensed horizontal temperature gradients resulting from thunderstorm downdrafts and outflow, gust fronts and fast moving frontal zones. This system is similar to that described by Kuhn, Caracena and Gillespie (1977).

When employed in the single band mode with a forward weighting function defined as "look-distance", $\delta\tau(\upsilon,\chi)/\delta\chi$ (change in transmission with respect to horizontal path), peaking at 5.0 km, anomalies in the constancy with descent or ascent of the potential temperature, θ, provide the alerting criteria. In the two-band mode, Figure 3, a second filter in the radiometer system with a forward look-distance peaking at two to four hundred meters, provides a reference ambient temperature. Differences between the sensed temperatures in the two bands, ΔT, provide the alerting criteria. Pitch angle of the aircraft during approach is compensated for thus eliminating hard targets.

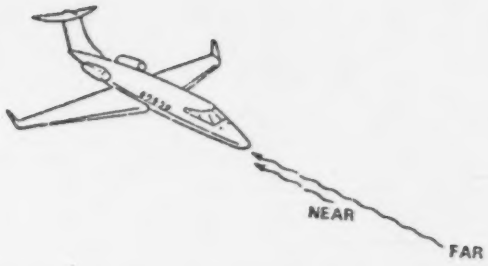

Fig. 3 A schematic depiction of the operation of a two channel IR-LLWS radiometer system.

The width of the pass band is important to consider in designing an IR-LLWS radiometer. The theoretical discussion below shows that narrow pass bands give the best spatial discrimination of thermal perturbations, while broad pass bands give the strongest corresponding perturbations in the radiometer output.

The radiative transfer equation (RTE) provides the theoretical background for interpreting test data, and for designing the IR-LLWS sensor. Where atmospheric radiation is incident on a radiometer along a horizontal path the incident radiation from the air alone is specified by the simplified form of the RTE,

$$N = -\int_0^\infty d\nu\phi(\nu)\int_0^\infty dx\ B(\nu,\ T(x)\delta\tau(\nu,x)/\delta x \qquad (1)$$

where

$$\tau(\nu,x) = e^{-k(\nu)x} \qquad (2)$$

$$k(\nu) = k(\nu)q\rho_o \qquad (3)$$

In this expression

N and B are radiances (w cm^{-1} sr^{-1})

$\tau(\nu,x)$ is the spectral transmission function (dimensionless)

$T(x)$ is the air temperature (°k) along a horizontal path

q is the CO_2 mass mixing ratio (dimensionless)

ν is the wave number (cm^{-1})

$\phi(\nu)$ is the filter function (cm)

$k(\nu)$ is the spectral absorption coefficient ($cm^2\ g^{-1}$)

ρ_0 is the air density at the radiometer leve ($g\ cm^{-3}$)

Weighting functions at altitudes of 33 meters (100 feet) through 491 meters (1500 feet) were run in the 660 through 710 cm^{-1} mass band at intervals of 10 cm^{-1}. The pass band centered at 695 cm provided the best "look-distance" or weighting function for the radiometer system (Figure 4). The "look-distance" was approximately 5 km (2.9 miles) providing some 80 seconds of warning or alert time for a shear encounter.

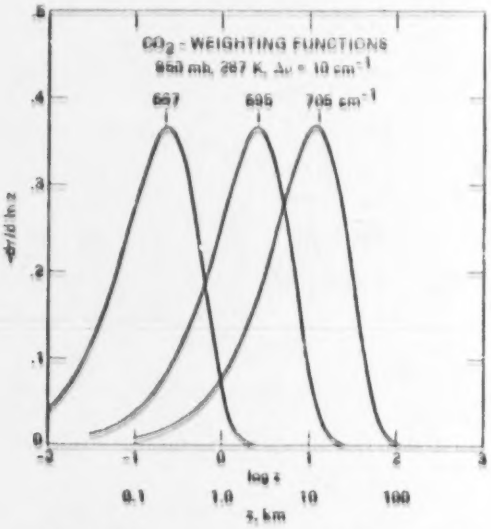

Fig. 4 CO_2 weighting function for pass-bands 10 cm^{-1} wide.

While it is clear that the best weighting function to use would be a spectral (single frequency) weighting function, in order to have a detectable signal in a low-cost, non-cooled IR system we must choose a filter with some finite spectral width. A spectral width of 10 cm^{-1} is now a feasible solution to a system able to sense temperature changes (radiometrically) of 1° C. With a cooled detector these changes could be as small as 0.1 C but the cost and complexity of the system would also multiply by at least ten. Hence a non-cooled, pyroelectric IR detector is adequate, and relatively simple to install and use in an aircraft. Since, as stated in the section on the "atmospheric physics of Low-Level Wind Shear" that a negative temperature perturbation of 4°C defines the lower threshold for severe wind shear, current non-cooled IR detector technology is adequate for a LLWS warning system.

The operation of the IR LLWS detection system is depicted schematically in Figure 5. The IR radiometer upon receiving a signal through its optical train generates a smoothed DC signal from the AC signal produced by alternate CO_2 and reference sensing. Here θ_1, θ_2 refer to near and far "look-distance" filters at the radiometer head and L_1 and L_2, near and far x distances. Figure 6 is the IR hull probe and right angle, gold-coated mirror facilitating mounting in the aircraft in various locations. The probe for signal reception in the forward direction may be rotated to compensate for aircraft attitude during approach or departure. The operation of the radiometer has been described by Caracena, Kuhn, and Kurkowski (1981).

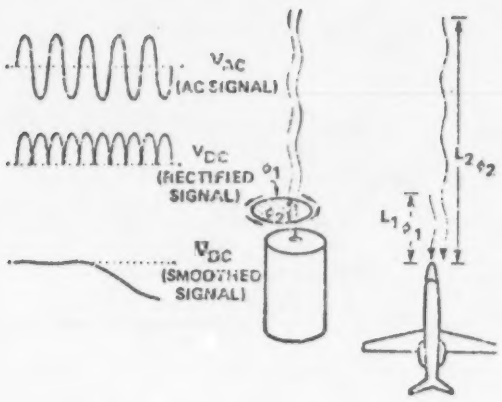

Fig. 5 Depiction of operation of the IR-LLWS detection system.

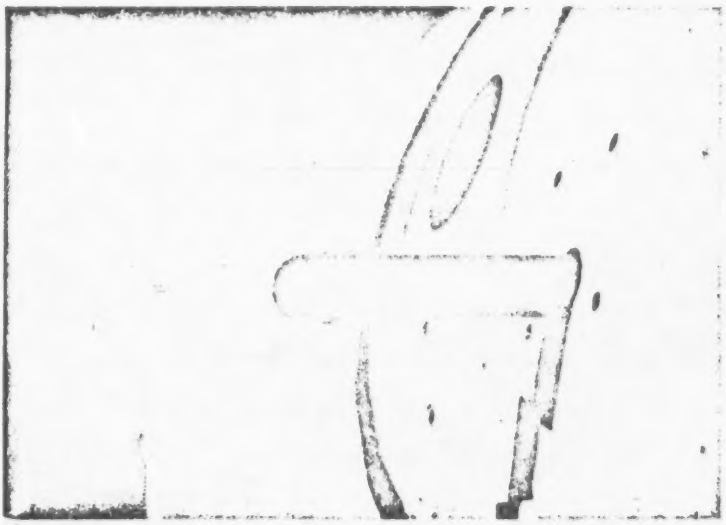

Fig. 6 Opitcal IR probe on starboard side of NASA Ames Learjet 24.

In a horizontally uniform temperature field both the near filter channel of the radiometer or the static air temperature at the aircraft and the forward far filter channel of the radiometer see the same temperature. As a cool outflow air mass is approached, the far channel will begin to sense a cooler temperature until the cool air mass approaches the aircraft. This results directly in the detection of the temperature difference or gradient $\Delta T(°C)$, noted in the previous section, which becomes the basis for the identification and prediction of impending low-level wind shear along the flight path. The precision of the LLWS IR radiometer is ±1°C maximum ranges.

PRELIMINARY AIRBORNE LLWS IR RADIOMETER TESTS

Initial flight data just received from NASA from the B57B runs of the JAWS Denver series with the fixed range IR detector on is July 1982 represent data for simulated ILS approaches from 6500 ft MSL (1300 Ft. AGL) to simulated touchdown. In one case, from the first analyses, the on-board infrared radiometer displayed a sharp temperature drop reaching approximately 7.0 °C approximately 3 miles and 70 seconds ahead of the simulated touchdown point. In the last 70 seconds to the touchdown point wind speed and direction changed from 358° at 15 knots to gusts from 180° at 46 knots (27 m/s). This was associated with a downburst--generated gust front with radial dust patterns reported by ground personnel. The IR warning system displayed the gust front temperature drop 70 seconds or 3 miles ahead of the shear area. Over the

simulated touchdown position vertical acceleration (z-axis turbulence) ranged from 0.9 g's to 2.00 g's in the moderate to severe category. Two other approaches on the 15 July 1982 demonstrated the same IR radiometer capability to forewarn of wind shear conditions. One should note that severe gust front conditions can display much higher temperature deficits, reaching 20°C to 25°C.

Preliminary tests of the LLWS radiometer system have been conducted aboard the NASA Ames Research Center Learjet in the late summer of 1981 at Travis Air Force Base and Suisun Bay northeast of San Francisco (Kuhn, et al., 1982). Data from these missions demonstrate the ability of the system to detect temperature anomalies due to effects of sea breeze on approach from altitudes of 300 to 430 meters (1000 to 1300 feet) at 30 to 70 seconds prior to aircraft encounter with the cool air mass and, in one case, light wind shear.

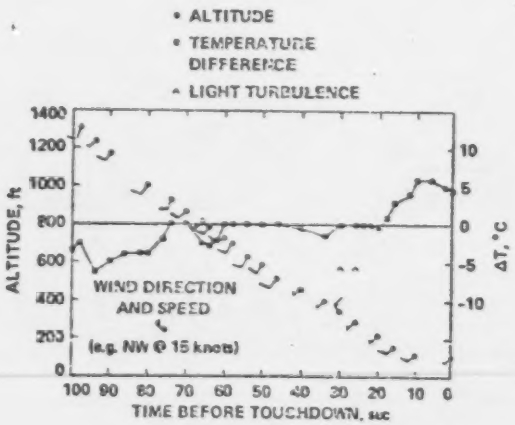

Fig. 7 Learjet data plots for approach to Travis Air Force Base, 1448 PDT, 1 September 1981.

Figure 7 presents the approach pattern and winds of 7 September 1981 at Travis and the $\Delta T/\Delta$ (°C)·(forward IR radiometer air temperature minus the static air temperature at the aircraft) as a function of altitude and time before touchdown. The optics elevation angle with respect to the aircraft center line is set at -4.0°. The nominal aircraft pitch angle for approach configuration is 3.0° with respect to the horizontal and the radiometer elevation angle is then approximately -1.0° below the horizontal. At 68 seconds out, or T-68, the distance out at 140 knots is approximately 4.7 km (2.72 miles) and the minimum height of the cool air mass simulating a gust front would be 82 meters (250 feet) for the radiometer to "see" it.

Based upon an examination of these early data, an indicator for predicting cool outflow ahead was arbitrarily chosen to be $\Delta T/\Delta t$ = 0.5 C/sec. The alert to this simulated cool gust front ahead could have occurred at approximately 100 seconds out but no later than 68 seconds before touchdown. In Figure 7 at T-20 $\Delta T/\Delta t$ becomes positive as the radiometer begins to "see" warmer hill areas beyond Travis. The top of the cool air mass as the aircraft descended was observed at 95 meters (290 feet) MSL. Light turbulence occurred at 105 meters (320 feet).

A similar advance warning of a cool air mass, again simulating a gust front outflow, is depicted in Figure 8. $\Delta T/\Delta t$ reached the 0.5C per second threshold at T-70 seconds. Here, the approach on 31 August 1981 to a simulated landing, is over Suisun Bay just south of Travis. Again, at T-12 $\Delta T/\Delta t$ becomes positive but less pronounced than in

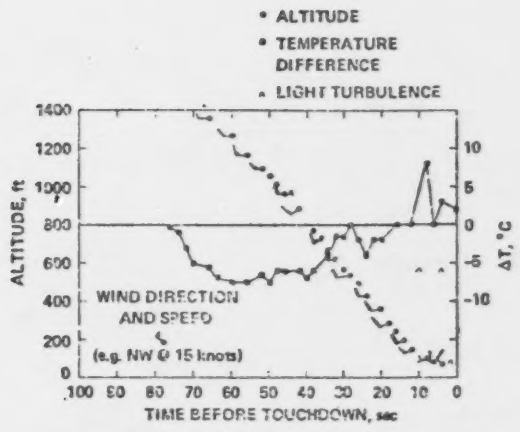

Fig. 8 Learjet data plots for approach to Suisun Bay, 1,340 PDT, 31 August 1981.

the Travis approach (Figure 7). The cooler oceanic inflow air is more extensive and the "look" angle of the radiometer is directed more to the larger bay and sea air. Light turbulence was encountered at an altitude of 49 meters (150 feet) with a wind shift of from 250° at 15 knots to 310° at 20 knots. The height of the turbulence is directly related to the shear zone in the vertical and horizontal but presumably can occur over considerable depth due to mixing. In this approach, the top of the cool air was approximately 65 meters (200 feet).

In Figure 9, illustrating another approach to Suisun Bay on the 31st of August 1981, $\Delta T/\Delta t$ exceeded the threshold indicating a cool, simulated gust front ahead at T-90 seconds. In both previous approaches as in this and the succeeding approach the patterns were flown between 1330 and 1500 PDT. At T-28 seconds the aircraft is obviously close to if not immersed in the cool air at an altitude of approximately

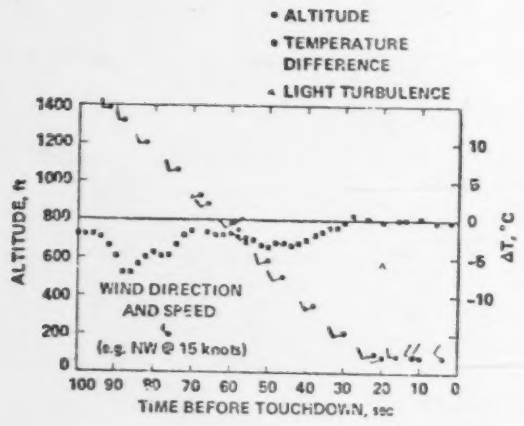

Fig. 9 Learjet data plots for approach to Suisun Bay, 1382 PDT, August 1981.

59 meters (180 feet). As in the previous approach over Suisun Bay, the background into which the radiometer "looked" was relatively cool for some distance out as evidenced by ΔT remaining essentially 0°C. Again light turbulence occurred at 40 meters (120 feet) MSL during a wind shift of from 250° at 20 knots to 300° at 10 knots. The turbulence does occur near the estimated top of the cool air mass.

On the 2nd of September 1981 (Figure 10) during a mid-afternoon approach to Travis from T-100 to touchdown $\Delta T/\Delta t$ did not reach 0.5C per second. There was no following encounter with cooler than ambient air and at T-20 the forward "looking" radiometer detected warmer air beyond the Travis runway area. No turbulence was encountered and no wind shift occurred during descent.

LLWS IR Radiometer Tests and Radiation Physics Applied to Instrument Design. The further research with the existing instrument here required is that of an early summer, Denver area test of a multi-range radiometer, operable with three or four various IR filters resulting in a 3 or 4 range system.

The airborne IR shear sensing system could have forward, sweep thermal scanning during which forward ranging by spectral scanning in the CO_2 band would provide range information to the hazardous shear ahead. Spectral information along the scan paths may be combined and micro-processed to yield a changing panel meter or CRT display in the horizontal plane forward and off axis of the flight track of the temperature structure and/or temperature deficit field. This may be displayed in color of symbolically.

As an aircraft approaches sufficiently cold outflow the radiometer system will progressively record a temperature depression of increasing magnitude. This will manifest itself in a changing or up-graded and up-dated warning of the impending shear area. This provides the airborne IR system with a degree of peripheral vision by horizontal scanning to the left and right of the forward direction or by a shaped mosaic of detectors utilizing a common optical system thus providing the pilot with avoidance (directional) alternatives. Spectral information along each azimuth is processed to yield the actual temperature distribution over the entire circular scan. Such information along all azimuths scanned may be combined and microprocessed to yield a CRT display in the horizontal plane against a background map of the airport

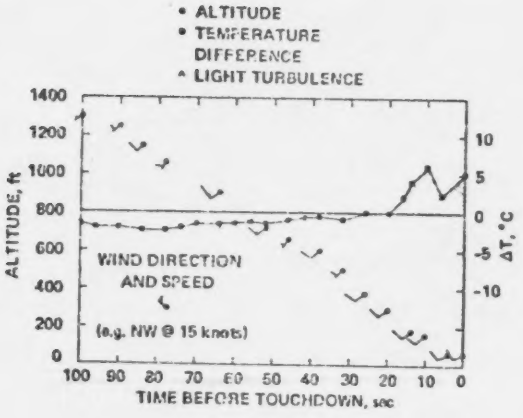

Fig. 10 Learjet data plots for approach to Travis Air Force Base, 1411 PDT, 2 September 1981.

REQUIREMENTS FOR OPERATIONAL TESTING OF FINAL PROTOTYPE

There are three primary approaches to a virtually immediate, low cost method for a short term forcasting of wind shear hazardous to safe aircraft operation. In our opinion ranked in order of importance they are:

1. Airborne, infrared forward-looking thermal radiometer detector.
2. Airport, ground-based infrared scanning and ranging thermal radiometer.
3. Surface grid network of anemometers.

In the two radiometer concepts, IR ranging is necessary and feasible.

1. Airborne IR System

The early success of this critical cockpit sensing and pre-warning system has been shown in the previous sections on the Preliminary Airborne

and its vicinity. Symbolic or color displays will indicate areas of probable, hazardous wind shear. The procedure whereby spectral IR data at a fixed azimuth are inverted and thereby converted into a temperature grid distribution is well-known. We have previously shown, with research references, the relationship of temperature deficits to gust front and downburst wind shear. Thus a single low-cost radiometer could provide a grid distribution of hazardous shear conditions. This would provide the pilot with additional information upon which to base a decision on aborting a takeoff or landing.

2. Airport, ground-based infrared scanning and ranging radiometer.

A ground based IR wind shear scanner would be equipped to thermally scan in a 360° circular sweep at low elevation angles. During this circular scan the instrument would perform a spectral scan to obtain temperature distribution at various ranges by sequencing filters in the CO_2 band. The grid and ranging are identical to the airborne IR system.

3. Surface Grid Network of Radiometers

A surface network of anemometers is a third alternative. The number of units and the uplink communication requirements would be quite extensive. A limited approach to this procedure has been employed with the positioning of anemometers adjacent to various airport runways at some airports. It does appear, however, that instrument, instrument calibration and the data gathering task would make this procedure a less viable alternative for the ground mode of shear warning than the scanning, IR thermal radiometer of Section 2 above which could

accomplish the same grid network result with a single instrument at considerably less cost and data acquisition cost. As noted, temperature retrieval from IR CO_2 band spectrally and position scanning radiometers is well known.

Subsequent to the preparation of the scientific and detailed technical section of this report a contact with NASA - Ames Research Center, R.L. Kurkowski and NASA - Dryden, W.D. Painter, indicated the advantage of employing the NASA - Dryden B57B aircraft for the proposed research effort. This aircraft was employed in a preliminary low-level wind shear project in a piggy back mode as part of a larger gust gradient experiment at Denver's Buckley Air National Guard Base for Dr. Kuhn's wind shear effort in July of 1982. Both Mr. Kurkowski and Mr. Painter pointed out the advantages of again employing the NASA B57B at Buckley in a dedicated flight series for low-level wind shear warning via the infrared. The Colorado Air Guard Base is ideal for the operation and the Denver FAA personnel are familiar with the type of flying required in the northeast Colorado region. This is to say nothing of the excellent NASA Dryden cooperation.

Both Mr. Painter and Mr. Kurkowski, colleagues of Kuhn, have further stated that while Northrop Services Inc. would scientifically man the project, if it can be initiated, it would be technically and economically advantageous to employ the NASA jet and NASA Dryden pilots who are familiar with the goals of the project. The Northrop Services relationship with NASA through Kuhn in this research area is excellent, reaching back several years.

The use of the Dryden jet would essentially cut costs by 40% over those costs when employing a commercial aircraft. It is believed the entire project could be accomodated for as little as $70,000. Final cost figures cleared by Northrop Services management will be forthcoming shortly.

Again, the preferred test area is that of the front range and eastern plains of Colorado, an area ideally suited, weatherwise, to the occurrence of isolated cumulonimbus cells, gust fronts and downburst activity. Moreover, surface data acquisition is definitely possible. Finally, the air traffic control in and to the north of the Denver area has participated in numerous flight weather experiments over recent years. Arapahoe County and Broomfield-Jefferson County airports afford excellent general aviation facilities and FAA tower control. This combined with excellent weather conditions during the summer months for airborne LLWS study would appear to point out Denver and northern Colorado as an ideal location for a three month operation.

To finalize a project ARIES operational testing of a prototype infrared LLWS radiometric alert system for in-cockpit use would require 60 hours of flight testing over a three month period. Prior to flight testing, three months would be required to procure, modify and install the IR LLWS system in the aircraft. Ideally, the Denver and north Colorado front range plains is the preferred geographical and environmental area for the prototype flight testing.

CONCLUSIONS

The preliminary results presented in this paper show that it is feasible to remotely sense horizontal temperature gradients associated with cool inflowing oceanic air masses ahead of an approaching aircraft with an on-board, IR radiometer system. Since gust fronts and thunderstorm outflow normally are associated with much stronger horizontal temperature gradients and often severe low-level wind shear it appears logical to conclude such radiometer observations ahead of gust fronts could readily detect these horizontal temperature gradients. It is believed that airborne tests in gust front and thunderstorm conditions would demonstrate advance warnings up to 7 kilometers (4.3 miles) in advance of wind shear encounters. This translates into warning times of up to 102 seconds. It is further proposed that a six months test, including a three month flight period, could demonstrate the feasibility of this airborne LLWS prediction system.

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